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As presently organized THE PSYCHOLOGICAL RECORD publishes both theoretical and experimental articles, commentary on current developments in psychology, and descriptions of research planned or in progress. The journal is designed to serve *a critical function in psychology*. It therefore favors the publication of papers that develop new approaches to the study of behavior and new methodologies, and which undertake critiques of existing approaches and methods.

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A THESAURUS OF PSYCHOLOGICAL TECHNIQUES AND VARIABLES

THOMAS B. SPRECHER
The Psychological Corporation

The problem of a literature search in psychology has grown so acutely due to the enormous accumulation of knowledge that all psychologists probably have approach-approach conflicts. Problems of where to start, which is the most fruitful topic heading to explore, and how to distribute the available time to get up-to-date, are pressing ones for all psychologists. Even more important than the approach-approach conflict, however, is the approach-avoidance conflict: necessary and useful as the literature search is, it steadily becomes more of a burdensome, repetitious search, and as the years go by the burden tends to increase geometrically rather than arithmetically.

There seems to be little hope of spending time efficiently and happily under the present state of affairs, useful as the *Psychological Abstracts* are for many purposes. While the *Psychological Abstracts* summarize the results of the applications, procedures and techniques, dealing with the generality of results and findings, they have changed little over the years. This is not to presume that changes are not in order, and indeed a committee of the APA recently has been set up to consider this very problem.[1] But in psychology reliance in the past has been placed upon handbooks or summarizations of a particular field such as appear in the Psychological Bulletin. Other systematic attempts to record and retrieve literature on an on-going basis have been made, such as by ASTIA and by the Bio-Sciences Information Exchange (Deignan, 1956), but the one is limited to literature published by the Armed Services, wide in scope as that may be in practice, and the other is limited to pre-publication information. Both of them use subject headings similar to those used in the *Psychological Abstracts*, with the advantages of descriptive familiarity but without the advantages that would accrue from a more systematic organization in a comprehensive framework.

Other sciences have developed such a comprehensive framework and are now in the further stages of documentation procedures (National Science Foundation, 1958 a, National Science Foundation, 1958 b) where alternative systems of mechanical recording are the chief point at issue.

[1] The committee report has been published, although overlooked by this investigator until this article was in press. The conclusions support the major contention here by indicating a need for "encyclopedic organization of knowledge and codification of methods, measures, and results." Board of Scientific affairs. Technical communication in psychology: a statement of the problem. *Amer. Psychol.*, 1959, 14,267-271.

Chemistry and other physical sciences are devoting considerable effort to simplifying the storage and retrieval of information, blessed as they are with a systematic theoretical organization of their subject matter. They have, while psychology still needs, agreement on the variables to be encoded in the system. Our difficulty is that a systematic and inclusive list of agreed upon variables is not available.

Any defensiveness about the difficulty of classifying psychological materials, because we are what some consider a social science and social sciences are notoriously vague, fails to lend us the proper armor when we consider the Human Relations Area Files. Murdoch (1950) has presented a comprehensive classification system used by the Human Relations Area Files for materials that anthropologists, sociologists, and other social scientists deal with daily. The Files have been a going concern for many years and proved of much immediate value during the Second World War by enabling compilations of data on particular cultures and geographic regions. Murdoch recognizes several comprehensive bases for classification, but has as a matter of practice by-passed the theoretical combinations and permutations possible to deal with common-sense categories actually used by workers in the social sciences.

To supplement these examples taken from scientific fields both more reductionistic and less reductionistic than psychology, where systematic frameworks have been set up, Altman and McGrath have presented "A Conceptual Framework for the Integration of Small Group Research Information." Their preliminary results are encouraging and in many ways supplement the approach to be outlined here. Their prime concern has been to set up a theoretically complete but limited set of research variables that are broad enough so that any study of small group relations would include one level from among each of the variables considered. By analyzing and reporting on the past and on-going accumulation of small group studies within this framework, confirmations, discrepancies, and gaps in the work being done would be readily apparent. Many details that are usually thought important are glossed over to keep the system within practical bounds, but the justified presumption is that the variables reported will be important enough to enable a survey of past work in addition to serving as a guide to future exploration.

The contrast with the *Psychological Abstracts* that the work by Altman and McGrath present is that of a theoretical organization which is comprehensive at the cost of simplification. Overlooking for the moment consideration of whether a theoretical organization which is all inclusive for small group research studies would be complete for studies in visual perception, physiological processes, learning, and so forth, there is no question but that it achieves this completeness by throwing out much information. Just as any research study ignores much potentially valuable information in order to concentrate on a more limited range of research variables, so an information system for the storage and re-

trieval of information has limitations on its capacity. For a different purpose, a different kind of capacity may be more useful.

My purpose here is concerned with the psychologist who is surveying a new field or aspect of psychology in order to design a piece of research. While all of us may be experts in one or another particular phase of research study, we are frequently enough forced to or delighted to, work with problems out of our customary bailiwick. When this happens we often turn to handbooks, but at the present time the primary step in investigating recorded information is to spiral out from a given topic or topics in the *Psychological Abstracts*. While it is probably true that an investigator could start with any topic heading, or even any journal article, and work out from its list of references to other articles and books and their lists of references until information suited to his purpose came to light, the *Psychological Abstracts* help him pick out the most likely fishing spots. This presumes, of course, that he knows what he is fishing for. Obviously, he knows something of what he wants, but who has not wondered if he has overlooked an important variable that is buried somewhere in the literature because it was so unexpected, or because it used a different word to describe essentially relevant phenomena, or treats as minor an idea and approach that seen in another context has major implications. Somewhat unwillingly, the investigator knows he is thrown upon his private resources, his personal memory banks, his individual associations and skill in pulling together relevant information from disparate studies.

Obviously, psychology has had a considerable degree of effectiveness and growth in spite of this handicap, because each individual psychologist who approaches the *Psychological Abstracts* has such an informal list of the variables that are likely to be important. Actually, in thinking about his experimental design, the psychologist probably has two separate lists: one for independent variables and the other for dependent variables. The psychologist may either want to achieve some change in his dependent variable(s), or to find out what effect a certain independent variable(s) has. Some overlap exists between the two lists, naturally, but the psychologist sees a kind of interplay between these lists. He wishes he could know and master all the relationships of each combination of several independent variables on each one or each combination of several dependent variables. He settles for a finite study of limited interrelationships, but perhaps in surveying the scientific literature to guide his own efforts he wishes that this information was already summarized the way he himself is forced to think in designing experiments.

The proposal here is based on the belief that agreement can be reached as to specific kinds of psychological variables and techniques to be classified as independent and dependent variables. The many separate lists which individual psychologists have can be combined into more inclusive lists. The important use is in systematizing the interrelationships of these variables so that the experimenter has the information at his finger tips.

After two such master lists are formed, independent variable "A" can be classified as having certain effects on dependent variables 1, 2, and 10. Independent variable "B", on the other hand, has certain demonstrable and classifiable effects on dependent variables 2, 4, and 5. If later investigation shows that "B" has an effect on dependent variable 7 as well, this can be added in. Dependent variable 1, of course, can be identified as being affected by independent variables "A", "C", "D", and "H." Problems of coding to deal with interaction effects need to be worked out, but are potentially solvable. The end result is a thesaurus which has a variety of uses and is flexible enough to permit expansion of its details to include both new information and new relationships.

To amplify the previous emphasis that psychology is concerned with the relationship between independent and dependent variables, it is recognized that this brings out only that part of psychology concerned with the process of manipulating behavior. Another part of the process of psychological science is the process of recording and measuring these manipulations and changes. In addition, all these various processes have results which are systemizations of accumulated knowledge. It is the conventional distinction between science as a process and science as a result. Besides identifying the fact that independent variable "B" has effects on dependent variables 2, 4, and 5, psychological science has handbooks, texts, monographs, and articles which summarize the details of the functional relationships involved. With these details of functional relations, there is no direct concern in this discussion. The concern is with the process of the science of psychology, as opposed to details of functional relationships, and such processes are subdivided into: (1) the independent and dependent variables used in effecting certain manipulations and (2) the process of recording and measuring changes in these variables.

Before presenting a general outline of a tentative system based on the above approach, some examples of what is meant by variables and techniques need to be given. Changing the schedule of reinforcement is an example of an independent variable which can be used to determine the kind of functional relationship between it and any of several kinds of dependent variables. The administration or withholding of water to an organism is also a variable, again one considered as an independent variable. Giving water orally or directly in the stomach are possible variations, and giving measured amounts versus ad libitum feeding is still another.

Under some circumstances, when investigating other independent variables such as salt in the diet, or heat, the amount of water consumed is a dependent variable, just as are the equally obvious ones of number of errors or number of right responses on a paper and pencil test.

The use of the motion picture camera can be considered as a technique useful to psychology, but more particularly in the process of recording and measuring changes. Let us suppose that the technique of analyz-

ing sequential motion picture frames was developed in the area of child psychology. It has more generality than that. Psychologists studying the learning of motor skills, the interaction of social groups, the group behavior of animals or Guthrie watching cats escape from puzzle boxes could and have found variations of the technique useful as a technique. Many broad rather than detailed techniques will be presented, since the presentation is important only as a suggested outline to clarify thinking rather than a finished product.

For instance, consider Outlines 1 and 2. In both of these outlines Section II is of primary interest but Section I has been included to indicate briefly areas of indirect concern to psychology, although not falling directly under its bailiwick.

The following describes how outlines 1 and 2 would be useful in studying the process of psychology as an experimental science manipulating independent variables to see the result on certain dependent variables. Outline 1 is of interest first since it describes selected kinds of independent variables. To illustrate Outline 1, take those variables classified in II-B-l-a—Food related. Here are grouped independent variables such as the time since feeding or electrical stimulation of the hypothalamus. Of course, any specific experiment would be concerned with stimulation of a particular area in the hypothalamus, e.g., but such details may be ignored at present. Having loosely defined the independent variable, Outline 2 is next examined to identify the kinds of dependent variables which could be used to identify the effects of such manipulation of the independent variables. The heading of II-B-l-a is the most directly relevant, and it identifies such obvious results as the seeking and ingestion of food, etc. But other dependent variables may also be related to the independent variable. Variations in oxygen consumption, classified under II-B-l-e may be another effect of any given independent variable, just as it is also possible that accuracy of motor learning may be affected. Obviously, sex-related activities, temperature, or social relations may also be independent variables which affect the ingestion of food. Other areas in Outline 2, such as those concerned with learning or perception will also affect the ingestion of food and have affected it in numerous reported experiments.

A psychological thesaurus such as is represented in embryo in Outlines 1 and 2 could also be cross-indexed so that an experimenter entering it, as in the hypothetical example, concerned with the dependent variable of food, would have his attention called directly to all the independent variables which varieties of previous experiments have shown to be relevant. If this was done the purpose, of course, would be to supplement rather than to supplant the *Psychological Abstracts* and so a notation that ingestion of food had been shown to be affected by, e.g., the presence of other individuals in a social setting, would not be elaborated beyond a brief referral to the particular psychological abstract which gave an expanded account of this relationship.

There obviously could be a considerable amount of judgment and

effort involved in identifying all these interrelationships. Even if some selectivity was used as to which past or recent experiments illustrated the relationship, considerable professional judgment would be required on the part of the classifier. If no such selectivity was used, the system might easily become too cumbersome. Such problems, real as they could eventually be, will not arise until a set of independent and dependent variables has been formulated. The belief here is that the list of variables in itself will be useful and that its existence could serve as a starting point for particular summaries of the existing state of the science insofar as interest for particular purposes centered around one or more independent or dependent variables. Thorough compilations of particular patterns and relationships should probably wait upon the particular interest or need of an individual or group.

However, it is also true that the very existence of the classification system embodied in the thesauraus would also suggest new relationships that might be explored or that alternatively might need to be controlled. An independent variable such as the color of the food being ingested might be suggested as a variable to be controlled or explored, whether or not previous experimenters had used such a variable.

Besides the independent variables and the dependent variables a psychological thesaurus should be concerned with techniques in recording data. An illustration of such an organization of these techniques is presented in Outline 3.

The usefulness of Outline 3, Recording and Measuring, lies in suggestions specifically aiding the operational procedures involved in making experimental observations. As the outline shows, the independent variables to be manipulated have first to be specified, then the dependent variables, and third, the conditions of observation. The changes in the dependent variables have then to be transferred to another area for observation and recorded on another object in some manner. The design of the experiment is the topic considered in the subsequent section although it understandably could well be considered much earlier. The observations have next to be formed into units and calibrated for recording, and this latter area, of course, is one of the concerns of psychophysics.

There are obvious interrelationships among the various parts of Outline 3 which render inapplicable certain combinations of techniques under different headings. For instance, if under II—Specification of dependent variables observed—an observer is watching a playground to count the number of social contacts any one child has, more than likely an observer would be used directly without recording and transferring these observations via the use of the motion picture camera. In other words, IV—Transfer of changes to another area for observation or recording—will not be directly involved.

Continuing the example, in Section V recording is on an organismic

object, the human observer. Interpretation by the observer is largely relied on rather than any specific conditioned response, although both of these are obviously types of organismic reactions which may be used in different experiments. There will also be special concern with Section VII–Calibration, the formation of units of observation–and here definitions and pretests are necessary to define what is meant by a social contact.

It is important to emphasize that the classification details presented here are in no sense final, but are intended to show that the details are solvable and that hope for development of such a thesaurus exists to a reasonable degree. The classification system as presented does not pretend to eliminate duplication, to find the unique spot for each independent or dependent variable or methodological consideration, nor does it pretend to present solely the "basic" variables. Obviously, some studies could be classified under two different headings, and for the convenience of experimenters should be so classified. For instance, time measures as independent variables might be included both under the food related headings as well as the heading of activity, the latter concerned with the natural rhythmns of the organism in its functioning. For maximum convenience, such duplication should be maintained, at least in the initial stages of the classification, because of the need to communicate with the experimenter in his natural language and approach. Murdoch (1950) reports that more usefulness has been achieved in the functioning of the Human Relations Area Files by keeping to empirical constructs rather than the more theoretical classification systems that could be devised.

The whole emphasis throughout this discussion has been on psychology as a process, on those aspects of psychology concerned with progress towards a result, and this result of the scientific method in psychology is, of course, knowledge. Knowledge in these terms is a summarization of existing information and trends, and, because this is where handbooks and textbooks are primarily concerned, the thesaurus as such would not get involved in this area. For the sake of completeness, the need to be concerned at some stage with the results of our experiments is recognized through Outline 4–Descriptive summaries. A brief study of a small sample of entries in the *Psychological Abstracts* was carried out, and the general indication was that the plurality of references in the *Psychological Abstracts* was to area I-B in Outline 4–Broad summarizations of several kinds or accumulations of data. The other references were scattered amongst the previously presented categories of independent and dependent variables. This is another indication that the present approach will help to organize the kinds of information the *Psychological Abstracts* contain and serve to guide the researcher to a better use of such information.

Several steps are necessary before a psychological thesaurus such as outlined can be instituted. Much more detailed expansion of specific

variables is necessary before all the advantages and limitations of the system are likely to be apparent. This expansion should take several forms. One approach is, of course, a thorough study of textbooks and handbooks to include variables and techniques basic to all areas of psychology. In part, this was the procedure used in forming the outline presented here and specific debts to books such as Andrews' *Methods of Psychology* (1948) and to technical reports such as Hochberg's *Methods in Psychology* (1953) must be acknowledged. Explorations of existing systems, such as the ASTIA system, the Uniterm system, and the Office of Basic Instrumentation at the National Bureau of Standards (Wildhack, Stern and Smith) would help to identify existing categories of concepts empirically found to be useful and to tie such a thesaurus in with presently functioning approaches.

Further elaboration can take place through inclusion of particular studies reported in journals, but certainly detailed checking of the thesaurus to line it up with carefully considered professional opinion is essential. Professional psychologists who are experts in particular areas must be involved in setting up the thesaurus to make its use by the same people effective. Pretesting of the usefulness of the thesaurus in an applied sense is another step towards maximizing its value.

In summary, a tentative classification system has been outlined which would result in a thesaurus of psychological techniques and variables. The thesaurus outlines basic experimental manipulations of behavior and the process of recording and measuring such manipulations. The type of approach presented allows flexibility in exhibiting mutual effects among the independent and dependent variables used, and in bringing new relationships to the attention of experimenters.

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APPENDIX

OUTLINE 1

Psychology as a process: *Independent variables*

I. Techniques to produce differences in nonliving matter
   A. Energy changes
      1. Sources of electrical energy
      2. Sources of mechanical energy
   B. Means of altering chemical composition
   C. Means of altering physical arrangements and composition

II. Techniques to produce differences in living matter
   A. Plant
   B. Animal
      1. Physiological
         a. Food related: time since feeding, lesions or electrical stimulation of hypothalamus, chemical substance in blood, etc.
         b. Water related: time since drinking, availability of liquids, time since food ingestion, etc.
         c. Sex related: time since copulation, presence or absence of genitals, presence or absence of opposite sex, hormones, etc.
         d. Circulatory system: characteristics of blood stream, heart, mechanical system, etc.
         e. Respiratory system: concentration of oxygen, functioning of lungs, etc.
         f. Central nervous system: characteristics of nerve impulse, summation, nerve pathways and interactions, etc.
         g. Activity: hypothalamic stimulation, natural rhythmic patterns
         h. Time: measures of the passage of time
         i. Temperature: devices for heating and measuring temperature
         j. Etc.
      2. Learning
         a. Characteristic(s) of task(s) or stimuli
            1) Passive or active presentation of stimuli by experimenter
            2) Previous acquaintance with task(s): can include meaningfulness, stimulus generalization, higher order conditioning, etc.
            3) Complexity of task(s): number; inherent difficulty; type of task presented; limited am't of time, material, or both, etc.
            4) Rate of exposure and absolute time of exposure
            5) Emotional tone, intensity of stimulus
            6) Characteristics of experimenter
         b. Characteristics of the Subject(s)
            1) ability of S's
            2) level of interest or motivation through: experimenter's instructions; manipulated report of results; selection of S's; measurement of existing interest; installation of difficult conditions.
            3) direction of motivation (positive or negative towards tasks)
            4) muscular tension or effort expenditure required
            5) internal inhibition through massed extinction trials, etc.
            6) conditioned inhibition through competing associations, etc.
            7) etc.
         c. Conditions for learning or forgetting
            1) Practice
               a) amount (including over and under-learning)
               b) distribution

c) deliberate vs. non-experimental practice
d) sequential practice (including learning to learn, interpolated practice, antecedent practice, etc.)
e) time measures

2) Reinforcement
a) amount (degree, increment or decrement)
b) kind of reinforcement (reward or punishment, change of kind of reinforcement, etc.
c) time measures (immediate or delayed)
d) conditions for presentation (invariably; dependent on correct response; partial reinforcement; etc.)

3. Perceptions
a. Visual—stationary objects
1) characteristics of objects observed
a) type of object (pictorial; verbal; numerical)
b) degree of ambiguity, specificity
c) degree of complexity
d) object as source of radiant energy (chromaticity, extensiveness, duration, luminous energy measures)
2) characteristics of background or field
a) type
b) degree of ambiguity, specificity
c) degree of complexity
d) background as source of radiant energy
e) simultaneous and alternative stimulation of other senses
3) characteristics of observing medium
(atmosphere effect, transmissivity, etc.)
4) characteristics of organism as a visual receptor
a) type of organism and physiological structure
b) retinal area of stimulation
c) accommodation, convergence, retinal disparity
d) attention and set of organism
e) direct stimulation of neural centers
f) etc.

b. Visual—moving objects
(relative motion; monocular movement parallax; stroboscopy, etc.)

c. Auditory
1) characteristics of source as stimulus
(frequency, amplitude, phase, wave form, location in space, etc.)
2) characteristic of background or field of stimulation
(as above in 1) plus simultaneous and alternative stimulation of other senses, etc.)
3) characteristics of observing medium
(density, foreign matter, etc.)
4) characteristics of organism as an auditory receptor
(type of organism, physiological structure, monotic vs. diotic vs. dichotic stimulation, head movements, etc.)

d. Taste and Smell
e. Etc.

4. Social relations and structures
a. Existing factors (should include generalized conditions cutting across topics below, such as measures of effectiveness of group, degree of communication within a group, stability, degree of inter-personal attraction, etc.)
1) Home factors (objective and subjective)
2) Community and cultural factors (objective and subjective)

3) Educational factors (objective and subjective)
4) Occupational factors (objective and subjective)
5) Recreational factors (objective and subjective)
6) Social adjustment (objective and subjective)
7) Personality and motivation (objective and subjective)

b. Manipulated
1) relative to other participants in experiment (cooperation; competition, individual vs. team; individual efforts; social stimulation)
2) with experimenter or experiment itself (attitude towards *E*, knowledge of fact of experiment being carried out, attitude towards purpose or auspices)
3) other manipulations under "Existing Factors."

5. Abilities, aptitudes, and knowledge (classification system based upon work of Cattell, French, and Guilford)
6. Differential variables (Opportunity for overcoming or by-passing limitation for research in . . .)
a. Ethics (death, required medical operation, etc.)
b. Central tendency (college or institutionalized persons, etc.)
c. Variability (no opp. to note variability vs. too little variability vs. too much) (general population sampling, physical accidents, etc.)
d. Time limitations (historical records, cross-sectional comparisons)
e. Financial limitations (volunteers, grants, free services, training opp., etc.)

OUTLINE 2

Psychology as a process: *Dependent variables*

I. Nonliving matter
A. Energy changes
1. Electrical
2. Mechanical
B. Chemical composition
C. Physical arrangement and composition

II. Living organisms
A. Plants
B. Animals
1. Physiological
a. Food related: food seeking, capturing, digestion, elimination
b. Water related: water seeking, ingestion, digestion, elimination
c. Sex related: partner seeking, capturing, copulation, gestation
d. Circulatory system: blood pressure, etc.
e. Respiratory system: oxygen intake, rate of respiration, etc.
f. Central nervous system: frequency of response, latency, velocity, electric potential gradients, etc.
g. Activity: measures of physical movement
h. Time: measures of time
i. Temperature: measures of temperature
j. Etc.

2. Learning
a. Motor
1) Accuracy measures (can include generalization vs. discrimination, recognition vs. recall, relational vs. individual responses, etc.)
2) Time measures include no response, latency, duration, rate of acquisition or extinction, reminiscence, retention, saving)

3) Frequency (intra vs. inter individual differences, etc.)
4) Evaluative responses
5) Magnitude of response (group or individual; time period)
6) Transfer of training
7) Latent learning

b. Verbal
1) Accuracy measures
2) Time measures
3) Frequency
4) Evaluative responses
5) Magnitude of response
6) Inappropriateness of response (lying, miss easy but get hard items)
7) Transfer of training
8) Latent learning

3. Perceptions
a. Visual
1) Direct measures
a) accuracy
b) time
c) frequency
d) evaluative responses
e) magnitude of response
2) Indirect measures
a) absolute thresholds
b) difference thresholds
c) organization of stimuli
d) constancy of stimuli
e) etc.

b. Auditory
(repeat above under visual)

4. Social relations and structures
(Should include generalized factors cutting across topics below, such as measures of effectiveness of group, degree of communication within a group, stability, degree of interpersonal attraction, etc.)
a. Home factors (objective and subjective)
b. Community and cultural factors (objective and subjective)
c. Educational factors (objective and subjective)
d. Occupational factors (objective and subjective)
e. Recreational factors (objective and subjective)
f. Social adjustment (objective and subjective)
g. Personality and motivation (objective and subjective)
h. Situational relations (particular or contrived situations, objective and subjective)

5. Abilities, aptitudes, and knowledge
(classification system based upon work of Cattell, French, and Guilford)

OUTLINE 3

Psychology as a process: *Recording and measuring*

I. Specification of independent variables manipulated or observed
A. Experimental manipulation
1. Selection of variables from OUTLINE 1
2. Means of control or presentation of source of independent variables
a. For particular variables under study
b. For control, elimination or balancing of extraneous variables

(time, space, position errors, spiral or homogeneous sub-tests format, etc.)
3. Sampling procedures (of S's, of experimental conditions, etc.)

B. Statistical selection
1. Selection of variables from OUTLINE 1
2. Means of measurement of particular variables under study
a. For particular variables under study
b. For control, elimination, or balancing of extraneous variables
3. Sampling procedures of S's (of experimental conditions, etc.)

II. Specification of dependent variables observed
A. Selection of variables from OUTLINE 2
B. Specification of measuring techniques for the dependent variables involved

III. Specification of conditions for observation (See VI and VII also)
A. Selection of observers (internal or external to experimental situations, etc.)
B. Means of control of other effects and dependent variables
C. Identification of cue points observed
1. Location physically, temporally, or as dynamic relations
2. Natural or artifically added cues
D. Time measures
1. Sampling (at one time period, across several time periods longitudinally or via cross-sectional approach)
2. Means of recording time (as separate added measure or interpretation of records directed towards other purposes)

IV. Transfer of changes to another area for observation or recording
A. Obtaining observation of dependent variables
1. Removal of material
2. Changes of attitude
3. Placement of observer
4. Strengthening of sense modality used
a. Visual (telescope, microscope, camera, Titchnerian training, etc.)
b. Auditory
c. Etc.
5. Errors customarily found
(time, place, position, rating errors)
6. Instrumentation for transforming from one sense modality to another to allow awareness of changes
(electrical to mechanical; electrical to chemical; physical to mechanical; mechanical to electrical; etc.)
B. Physical transfer of effects
1. Via physical movements
2. Via radiant energy
3. Etc.

V. Recording on another object
A. Type of object
1. Organismic (human vs. non-human; self-report; interviewer; observer; etc.)
2. Artificially constructed machine (phonograph; camera; stabilimeter etc.)
3. Physical surface (paper; metal; plastics; photographic film; etc.)
4. Any other substance
B. Means of recording
1. Deposition of substance (kind of substance; manner of deposition; instrument for deposition; etc.)
2. Release of a substance

a. Previously added to surface
b. Previously contained within a substance or instrument
c. Cutting operation
d. Change of state of substance

3. Learned interpretation of differences by organisms

VI. Experimental design (functional vs. factorial; classical single variable design; multivariate analysis; matched-pair technique; etc.)

VII. Calibration, the formation of units of observation

A. Direct

1. To what are the behavioral units (static or action properties) compared?
   a. Organism's implicit adaptation level
   b. Each other (within individual, group, or across groups)
   c. One (or more) standard stimulus
   d. Conventionally established units (Electrical, physical, time, or behavioral)
2. How are the comparisons made?
   (Nominal, Ordinal, Equal interval, ratio judgments)
3. How are the finished judgments presented?
   a. Verbal summaries
   b. Previously trained or instructed choices in physical actions

B. Refinement of units through a mathematical or rational interpretation

OUTLINE 4

Psychology as a result: *Descriptive summaries*

I. Classification and description of observations

A. Particular statistical manipulations of data
(Measures of central tendency, variability, etc.)

B. Broad summarization of several kinds or accumulation of data
(Including qualitative and quantitative summaries)

II. Reliability of observations

A. Statistical manipulations to observe significance of differences and relations observed

B. Repeated experiments—direct and indirect

C. Typical errors in observations

III. Logical bases for classification of observations

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PERFORMANCES OF PSYCHIATRIC PATIENTS IN A BRIEF OPERANT DISCRIMINATION TEST[1]

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"Contact with reality" is an important concept in psychiatry. One distinction between psychotic and neurotic patients assumes that the former are more likely to exhibit disturbances in reality contact. Among the schizophrenias, the symptoms of withdrawal, inappropriate affect, disassociative thinking, and ambivalence all have as one accompaniment a lessening of the individual's contact with his environment. Clinically, the schizophrenic condition is characterized by an altered sense of reality, a weakening of ego-boundaries in which the individual has difficulty discriminating between forces within himself and forces in the environment. These considerations lead quite readily to the expectation that psychotic patients, when compared with nonpsychotic patients and nonpatients, will be less amenable to the control ordinarily exerted over operant behavior by various reinforcement contingencies. This "hypothesis" has received support in several studies.

Lindsley (1956) has shown that under variable interval reinforcement schedules chronic psychotic patients are less able than are nonpatients to maintain sustained responding. Mednick & Lindsley (1958) have reported a significant relation between "pauses" (interresponse times greater than 10 secs.) in variable interval performances of chronic psychotic subjects and independent clinical data. King, Merrell, Lovinger, & Denny (1957) have reported that among acute schizophrenic patients, the most severe cases were least likely to develop high rates of responding under conditions of progressively increasing fixed ratio reinforcement. Bullock & Brunt (1959) have found that under conditions of monetary reinforcement psychotic patients are less likely to be testable than nonpsychotic patients, and psychotic patients who have been ill for more than a year are less likely to be testable than those who have been ill for shorter durations.

The studies cited above indicate that psychotic patients are less likely to be amenable to experimental control in operant conditioning

[1] This is a modified and expanded version of a paper read at the Conf. Exper. Anal. Behav., Amer. Psychol. Assoc., Sept. 1959. The research was supported by matching grants from Lilly Research Laboratories and Wyeth Laboratories, a separate grant from Wyeth Laboratories, funds from the Theano Foundation (Mrs. E. Paul DuPont, and funds of the Pennsylvania Hospital. The author is Research Psychologist, Psychological Service, Inst. Penna. Hosp., 111 N. 49 St., Phila. 39, Pa. Manly Y. Brunt, Jr., M. D. Clinical Director, North Building Service, collaborated in the research. Invaluable assistance was provided by Per-Olof Therman, M. D., Director of Research, James J. Dixon, Ph.D., Chief, Psychological Service, and J. Martin Myers, Jr., M. D. Director, North Building Service.

situations, and suggest that operant motor behavior is subject to psychopathologic influences. At the same time, the experimental analysis of operant behavior in mentally ill persons involves important difficulties.

One difficulty is that of developing suitable reinforcers. Lindsley's (1956) data show that candy can be used effectively with many chronic psychotics, and Bullock & Brunt (1959) have found that acute psychotic and nonpsychotic patients can be motivated by money. But there is still a need for additional incentives and for systematic data relating reinforcer effectiveness to clinical data.

A second difficulty is that of the duration and frequency of experimental sessions. The usual procedure in operant studies is to expose the subjects to repeated sessions until performances stabilize. The experimenter may introduce instructions designed to expedite the development of control (e.g., Dews & Morse, 1958), but ordinarily several sessions are required for stable behavior to materialize. Lindsley (1956) uses the procedure of frequent testing: his chronic psychotic patients are tested one or more hours per day, five days per week, sometimes for years.

With more acute psychiatric patients, the use of frequent sessions can be somewhat less feasible. The acute patient is more likely to be motivated by money, so that financial considerations can acquire real significance. There is another, more crucial problem associated with the use of frequent sessions for stabilizing performances in acute patients. The acute patient is likely to be hospitalized for relatively short time periods during which he is likely to show considerable variability in his clinical status. With respect to psychopharmacologic studies, little time may be available for obtaining a baseline, since from the clinical viewpoint it may be desirable to initiate drug treatment at admission. Even when for the purpose of experimental analysis, the initiation of pharmacotherapy is postponed temporarily, the time available for stabilizing a performance will be brief. Generally speaking, the acute psychiatric patient has little to commend him as a subject for the typical operant experiment. Yet we can hardly ignore him, nor claim that his operant behavior is unimportant in the total scheme of things. There is a genuine need for effective means with which to analyze operant behavior in the acute psychiatric patient.

One possible approach to this problem is to develop briefer operant procedures with which to assess the individual's amenability to experimental control. Preliminary data suggest that this approach may be feasible. Bullock (1957) tested university students under conditions in which leverpressing was reinforced intermittently with the word *right*, and found that a considerable degree of experimental control could be exerted over 67-75% of the subjects within a single 50-min. session. Bullock & Maline (1958) obtained differences between retarded and nonretarded subjects of comparable mental ages in a single operant test

session lasting 55 mins. Brief operant tests can generate reasonably high test-retest reliabilities. King (1956) gave three 30-min. operant tests to acute schizophrenics on three consecutive days, then repeated this procedure two to three months later. In two samples (N=11, N=13), the "rhos were above .85."

In this paper, data will be presented for patients and nonpatients who have been given a brief visual discrimination learning test in an operant conditioning situation. The use of discrimination learning contingencies was based upon the following considerations. First, discrimination learning seems to offer a reasonably direct approach to the problem of evaluating so-called "reality contact." The "reality" which is being "contacted" can be defined operationally in straightforward manner. Little controversy is involved in the assumption that given two stimulus conditions, one of which identifies reinforcement and the other nonreinforcement, the healthy, mature, reality-oriented individual will (under appropriate circumstances) learn to discriminate between the two stimulus classes. Second, Lindsley (1958) has reported data on visual discrimination learning in chronic psychotic patients which indicates that they exhibit various forms of inability to develop appropriate performances. Third, our own exploratory data suggested that the discriminative behavior of patients and nonpatients, or more precisely, their behavior under discrimination contingencies, was likely to be quite different. Finally, discrimination learning is a basic behavioral process.

METHOD[2]

Subjects. Fifty-eight subjects were tested: 17 nonpatients (8 female student nurses, 2 female university students, 7 male university students); 12 nonpsychotic psychiatric patients (7 females, 5 males); 14 schizophrenic patients who had been ill for less than a year, the "less chronic" group (9 females, 5 males); and 15 schizophrenic patients who had been ill for more than a year, the "more chronic" group (8 females, 7 males). All of the patients were hospitalized in a private psychiatric hospital and most were on some form of pharmacotherapy at the time of testing. The age and diagnoses of the patient groups approximate those reported previously (Bullock & Brunt, 1959).

Procedure. The general method was that described by Bullock & Brunt. The subject sat alone in a small room, where he faced a panel containing two small metal knobs separated by a reward tray. Knob-pulling responses were rewarded with money: poker chips which the patients exchanged for credit vouchers with which they could make purchases in the hospital Snack Bar. Nonpatients and those patients allowed to carry money exchanged their chips for cash.

Each subject was given a brief visual discrimination learning test.

[2] Mr. Richard Sorokin, Mrs. W. Robt. Moore, Mrs. George Avery and Miss Jean Strouse contributed materially to the conduct of this research.

Initially, a lamp over the right hand knob was lighted and responses on the right hand knob were rewarded. Left knob responses were not rewarded. Following a series of "trials" in which right knob responses were first rewarded continuously and then on a 26-sec. fixed interval reinforcement schedule (Ferster & Skinner, 1957), the discrimination test was introduced. At the start of each discrimination trial, the lamp over the left knob was lighted and that over the right knob was off. The left knob lamp remained lighted for 26-secs., during which time neither knob would produce chips. At the end of this 26-sec. left knob lighted no reward interval, the left knob lamp went out and the right knob lamp was lighted. The next right knob response produced a chip, and started the next trial. The discrimination test consisted of 20 trials.

RESULTS

Three criteria were applied to each subject's performance for the purpose of assessing how much attention he was paying to the knob lights and whether he was learning not to pull the knobs when the left knob was lighted.

Criterion No. 1 – decreased responding on both knobs during the left knob lighted no reward periods. Since the lighted left knob lamp identified periods of nonreinforcement, it was assumed that behavior in these periods should decrease ("extinguish"), so that the subject would be emitting fewer responses at the end of the test than at the beginning. The total number of responses made on both knobs during trials 16-20 was divided by that made during trials 1-5. Values below 1.0 were taken as evidence of decreased responding.

Criterion No. 2 – as many or more left as right knob responses during the left knob lighted periods. Pilot data (Bullock & Brunt, 1958) indicated that nonpatient subjects were more likely than patients to show what might be termed "stimulus-response generalization" during the left knob lighted periods: a marked transfer of responding from the right to the left knob in response to lighting of the left knob. Though it is probably questionable to attribute this strictly to stimulus-response generalization resulting directly from the subjects' prior experience in obtaining rewards via the lighted right knob (the subject's pre-experimental history undoubtedly played a role in controlling this behavior), the performance on the left knob does provide evidence concerning the discriminative control exerted by the knob lights. The number of left knob responses made during the left knob lighted, or S^{Δ}, periods for trials 1-20 was divided by the total number of right and left knob responses emitted during the S^{Δ} periods. Values of .5 or higher were taken as evidence of significant discriminative control.

Criterion No. 3 – obtaining each reward within 1.5 secs. after the right knob lamp was lighted at the end of each no reward period. The first right knob response occuring after the right knob lamp was lighted

produced the next reward, so that lighting of the right knob lamp was the discriminative stimulus associated with reinforced knobpulls. The latency of this discriminated operant (right knob lighted–pull the right knob) can be assumed to reflect its strength. Since prior to the introduction of the discrimination trials the right knob response was given both continuous and then fixed interval reinforcement in the presence of the lighted right knob lamp, it is reasonable to assume that during the discrimination trials this behavior should be maintained. The actual measure applied was the mean interreinforcement interval for trials 1-20. A value of 27.5 secs. (26-sec. no reward interval plus 1.5 sec. latency) was selected as indicative of relatively strong discriminative control.

Given these three criteria, a subject's performance in the discrimination test would be said to reflect a "normal" degree of discriminative stimulus control if the subject yielded (a) a value of less than 1.0 on Criterion No. 1 (i.e., made fewer responses in the last 5 trials than in the first 5); (b) a value of .50 or more on Criterion No. 2 (i.e., made half or more of his S$^{\Delta}$ responses on the left knob); and (c) a value of 27.5 or less on Criterion No. 3 (i.e., averaged 27.5 secs. or less on his interrein-

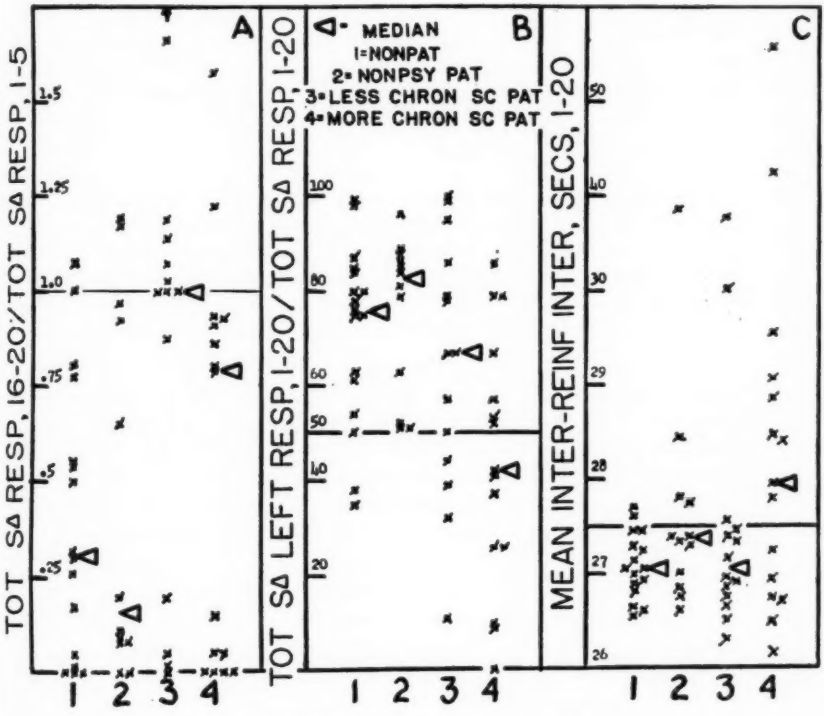

Fig. 1. Individual data by groups for each criterion.

forcement intervals by responding to the lighted right knob within 1.5 secs.).

In Figure 1, the individual data have been plotted separately by groups for each criterion. The median values for each group on each criterion are designated by arrowheads and the "normal" discriminatory performance criterion value limits are shown by horizontal lines. Panel A=Criterion No. 1, Panel B=Criterion No. 2, Panel C=Criterion No. 3. One nonpatient subject was inadvertently omitted from Panel A (his value=.55) and from Panel C (value=27.3). The subjects are not individually identified. The actual criterion values for each individual can be obtained from the author.

Fifteen subjects failed to attain Criterion No. 1: 13% were nonpatients, 17% were nonpsychotic patients, 60% were "less chronic" schizophrenic patients (ill for 1 yr. or less), and 13% were "more chronic" schizophrenic patients (ill for more than 1 yr.).

Fourteen subjects failed to attain Criterion No. 2: 14% were nonpatients, 0% were nonpsychotic patients, 29% were "less chronic" schizophrenic patients, and 50% were "more chronic" schizophrenic patients.

Eighteen subjects failed to attain Criterion No. 3: 11% were nonpatients, 22% were nonpsychotic patients, 17% were "less chronic" schizophrenic patients, and 50% were "more chronic" schizophrenic patients.

Five subjects failed to attain any of the criteria: all five were "more chronic" schizophrenic patients.

Though the data in Figure 1 suggest "trend" differences among groups with respect to the individual criteria, it is clear that considerable overlapping occurs. The "less chronic" schizophrenic subjects were least likely to show a decrease in responding in the discrimination test, whereas the "more chronic" schizophrenic subjects were the least likely to show "stimulus-response generalization" and least likely to show short latencies

TABLE 1

THE PROPORTIONS OF SUBJECTS IN FOUR DIFFERENT GROUPS (NONPATIENTS, NONPSYCHOTIC PATIENTS, "LESS CHRONIC" SCHIZOPHRENIC PATIENTS, "MORE CHRONIC" SCHIZOPHRENIC PATIENTS) WHO ATTAINED EACH OF THREE DISCRIMINATORY PERFORMANCE CRITERIA, AND THE PROPORTIONS ATTAINING ALL THREE CRITERIA.

	All 3 Criteria	Criterion No. 1	No. 2	No. 3
17 Nonpatients	70%	88%	88%	88%
12 Nonpsychotic patients	50%	83%	100%	75%
14 "Less chronic" Sc. Pat.	13%	36%	71%	79%
15 "More chronic" Sc. Pat.	20%	87%	47%	40%
29 Schizophrenic patients	17%	62%	59%	59%

in response to the right knob light. The nonpatient and nonpsychotic patient groups were the most generally similar to each other.

Table 1 presents the proportion of subjects in each group attaining each of the three criteria and the proportions of subjects in each group who attained *all three criteria.*

Statistical tests (X^2 using 2x2 contingency tables)[3] showed that the nonpatient groups differed significantly from both the schizophrenic patient groups ($p=.01$), whereas the nonpsychotic patient group did not differ significantly from any of the groups. When the nonpatient and nonpsychotic subject groups were pooled and compared with the pooled schizophrenic patient groups, the difference was significant.

Note that (a) though not one of the discriminatory performance criteria was sufficient by itself to differentiate between the nonpatient and schizophrenic patient groups, the combination of all three criteria did differentiate; and (b) there was a trend for the "less chronic" and "more chronic" schizophrenic patient groups to differ with respect to the specific criteria each group was most likely to attain. Generally speaking, this trend difference between the two schizophrenic patient groups can be attributed to the fact that the latter ("more chronic" group) was less responsive in the test situation.

In a subsequent study, the 20-trial discrimination test was given without previous continuous and fixed interval reinforcement (except for 5 initial continuous reinforcements). Twenty nonpatients (8 female hospital personnel, 2 female university students, 10 male university students) tested under these conditions showed significant learning. Of the 20, 17 or 85% yielded marked decreases in S^{Δ} responding and short latencies of response to S^{D}.[4] Fifteen acutely disturbed schizophrenic patients were also tested, of whom 7 were reported to be "improved" or

TABLE 2

FREQUENCY DISTRIBUTIONS OF "IMPROVED," "SOMEWHAT IMPROVED," AND "UNIMPROVED" ACUTELY DISTURBED SCHIZOPHRENIC PATIENTS IN THREE DISCRIMINATORY PERFORMANCE CATEGORIES: "LEARNED," "DID NOT LEARN," AND "NOT TESTABLE."

	"Learned"	"Did Not Learn"	"Not Testable"
"Improved"	4	1	0
"Somewhat improved"	2	0	0
"Unimproved"	1	5	2*

* Both "acutely disturbed chronic undifferentiated schizophrenics."

[3] Formula 6.4, Sigel's *Nonparametric statistics,* McGraw-Hill, 1956.

[4] These subjects showed less "stimulus-response generalization" (i.e., less predominance of left knob responding during the left knob lighted intervals) than was obtained with the previous procedure, which suggests that continuous and fixed interval reinforcement associated with the lighted right knob prior to the discrimination trials played a role in controlling responding on the left knob when it was lighted.

"somewhat improved" and 8 were reported as "unimproved." Table 2 presents the data for the patient subjects. Their performances have been termed "Learned," "Did not learn," or "Not testable." The data suggest that a relationship may exist between a patient's clinical status and the likelihood that his performance will be similar to that of nonpatients.

DISCUSSION

The aim of the research was to determine whether significant differences could be obtained between nonpatient and schizophrenic patient subjects in a brief operant discrimination learning test. The data indicate that (a) schizophrenic patients were significantly less likely than nonpatients to attain all three discriminatory performance criteria applied to the performance data, and (b) the performances of schizophrenic patients tended to be related to clinical variables. The fact that unpublished pilot data yielded similar findings and the fact that the discriminatory performance criteria were based upon current concepts about discrimination learning lend some confidence to the finding that nonpatients and schizophrenic patients performed differently. At the same time, since the specific criterion values applied were based upon the nonpatient data, the reproducibility of the differences can only be determined via a replication for cross-validation purposes. With these limits, the results confirm previous reports of psychopathological influences upon operant behavior (Lindsley, 1956, 1958; Mednick & Lindsley, 1958; King *et al*, 1956, 1957; Bullock & Maline, 1958; Bullock & Brunt, 1958, 1959).

Assuming that the differences obtained are reproducible, how may we interpret them? The data cannot obviously be used to defend the proposition that schizophrenics are characterized by deficits in operant discrimination learning. The study did not include control conditions for assessing the role of variables such as "motivation," "test-taking attitudes," etc., nor were the nonpatient and patient groups matched with respect to age, education, socio-economic background, etc. Nor were the subjects given sufficient time to learn the discriminations: i.e., only a few of the nonpatients actually could have been said to have developed a terminal discriminatory performance, so that it cannot be concluded that the patients were less able to learn visual discriminations. As has been stated above, the aim was to examine performance differentials within the course of a relatively brief test. The data obtained, when combined with those reported by Lindsley (1958), do suggest that systematic experimental attention be given to the problem of operant discrimination learning in schizophrenia, since adequate data do not exist.

The Deviation Hypothesis formulated by Berg (1957) has some appeal as an interpretive concept. Berg (1959) has reviewed a variety of data which he interprets as supporting the Deviation Hypothesis, which he has stated as follows (Berg, 1957, p. 3);

> "Deviant response patterns tend to be general; hence those deviant behavior patterns which are significant for abnormality (atypicalness) and thus regarded as symptoms (earmarks or signs) are associated with other deviant response patterns which are in noncritical areas of behavior and which are not regarded as symptoms of personality aberration (nor as indicators, signs, earmarks)."

Though most of the data cited by Berg (1959) was verbal behavior data, he stated, "Stimuli for conditioned response, autokinetic and spiral after-effect perceptions involve noncritical areas of behavior in the sense that the responses are not regarded in themselves as symptoms or earmarks (p. 91)." and concluded that;

> "The evidence reviewed here is believed to indicate that there is nothing of special value in particular item content for objective personality and similar tests. Verbal content of the traditional kind used in personality tests is not essential; for a wide variety of content may be employed with equal effectiveness. Indeed, any content which produces deviant response patterns will serve, judging from the available evidence. The important thing is not particular content, but rather a series of deviant responses and operationally clean criterion groups . . . Thus . . . conditioned responses . . . may also be used (p. 95)."

In the present research, the data were analyzed in a manner similar to that used by Berg. The behavior of nonpatient subjects was the basis for specifying "normal" response patterns (more precisely, "normal" performance features). When applied to schizophrenic patients, the "normal" performance criteria yielded significant deviations, what might be termed deviant response patterns. Since the two groups of subjects were "operationally clean" in the sense that one consisted of non-hospitalized, nonpatient individuals and the other consisted of hospitalized, patient individuals, the occurence of significant differences between them, when their data were analyzed in the manner described here, provides preliminary support for Berg's contention that the Deviation Hypothesis can be extended to "conditioned responses." Thus, we reach the simple, undramatic, and hardly original conclusion that the "deviant response patterns" known to characterize schizophrenic patients at home, at work, in the psychiatric interview, and in the clinical psychological test situation also enter the laboratory and show up in a brief operant discrimination learning test.

There seem to be two areas of investigation which deserve systematic experimental attention:

1) Determining the degree to which inter-subject variability ("individual differences") in human operant behavior under experimental conditions will be correlated with "deviant response patterns" defined by independent psychological test data. This research area has important implications for the formulations by Berg (1957, 1959) and by Cronbach (1957).

2) Determining the degree to which "acute" schizophrenics are characterized by deficiencies in their operant discrimination learning processes, rather than merely by general "deviant response patterns" which transfer into laboratory situations. This research area has important implications for the analysis of operant behavior in psychiatrically disturbed individuals and for theories which involve the assumption that "acute" schizophrenics can benefit materially from "learning" due to psychotherapeutic intervention.

SUMMARY AND CONCLUSIONS

Fifty-eight subjects were given a brief operant discrimination learning test. There were four groups: 17 nonpatients, 12 nonpsychotic patients, 14 "less chronic" schizophrenic patients (ill for 1 yr. or less), 15 "more chronic" schizophrenic patients (ill for more than 1 yr.). All the patients were hospitalized in a private psychiatric hospital.

The subjects were tested in a small room, where they sat alone facing a panel containing two knobs separated by a reward tray. Knob-pulling responses were rewarded with money. A lamp over each knob could be lighted to provide visual stimulation.

The discrimination test consisted of 20 discriminated fixed intervals. Each "trial" involved (a) a 26-sec. no reward period in which the left knob was lighted and neither knob would produce rewards, the S^{Δ} condition. which terminated with (b) a reward period in which the right knob was lighted and the next right knob response produced one reward and started the next no reward period. These 20 discrimination "trials" were preceded by continuous and then fixed interval reinforcement of right knob responses with the right knob lighted.

The performances of the subjects were evaluated in terms of three criteria: (a) decreased total response rate in the S^{Δ} or left knob lighted no reward periods, (b) predominance of left knob responding in the left knob lighted no reward periods, and (c) latencies of 1.5 secs. or less in response to the lighting of the right knob lamp in each reward period.

Specific criterion values were established on the basis of the data from the nonpatients. The proportions of subjects attaining all 3 criterion values were: nonpatients 70% nonpsychotic patients 50%, "less chronic" schizophrenic patients 13%, "more chronic" schizophrenic patients 20%. The nonpatient group differed significantly from both of the schizophrenic patient groups.

In a subsequent study, using a modified procedure, data were obtained from 20 nonpatients and 15 acutely disturbed schizophrenic patients, some of whom were reported as "improved" and others as "unimproved." The trend was for the "improved" subjects to perform in a manner more similar to that of the nonpatients.

Subject to a cross-validation replication for the purpose of determining the reproducibility of the findings, the data suggest that in a brief operant behavior test session the performances of psychiatric patients will reflect psychopathological influences.

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SOCIOMETRIC CHOICE STATUS, EMPATHY, ASSIMILATIVE AND DISOWNING PROJECTION[1]

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In a previous article in this journal (Spilka and Lewis 1959), the authors presented a system for the operational derivation of empathy, assimilative and disowning projection measures from objective-type Yes-No questionnaires. This was apparently the first time the two forms of projection hypothesized by Cameron (1951) have been assessed.

In brief, this procedure may be summarized as follows: The judge fills out the questionnaire for himself and then as he feels the reference person would answer it. Finally the referent answers the questions for himself. The following operational definitions were utilized to separate the above factors:

Empathy. The score derived was the number of items in which the referent's form actually agreed with the judge's record when the latter filled out the questionnaire as if he were the reference person.

Assimilative projection. The score was the number of items which the judge assigned to the referent and which the former also perceived in himself, but which were not assigned by the referent to himself.

Disowning projection. This was the number of items attributed to the referent, but not assigned by the judge to himself, and also not perceived by the referent in himself.

Error. This was the remaining possibility for relating the judge's and referent's protocols which did not fall within the scope of the above definitions.

The validity of the above method was inferred initially from the nature of the interrelations among the different measures. Internal validity however is only suggestive, and the present paper represents an attempt to relate these measures to a meaningful external criterion, sociometric choice status.

[1] The writers are indebted to Mr. John F. Dunn for his aid and cooperation.

PROBLEM

It was the purpose of the present study to assess the relationship between sociometric choice status and empathy of the particularized other (Bronfenbrenner, Harding, Gallway 1957) when the various forms of projection and some other possible sources of error in empathic measurement are controlled. In addition it was desired to reveal how these other variables relate to sociometric choice status.

It was hypothesized that:

a. High choice status individuals will reveal significantly more empathy than individuals of low choice status.

b. Low status persons will reveal both more assimilative and disowning projection than high status persons.

c. The error term since it represents other essentially undefined interferences with social insight will be independent of choice status.

METHOD

Subjects. The subjects were 54 male students who comprised the 6th, 7th, 8th, and 9th grades in a private school. They ranged in age from 11 to 16 years. The home-room faculty members for these grades served as referents for the judgments made by the boys. The teachers were chosen to reduce the probability that empathy is a function of similarity of the judge and referent. In addition, all the boys in a given class had apparently equal contact with the teacher.

Tests. The sociometric devices employed required that each student rank his classmates on four sociometric criteria. A list of boys in his class was provided so that all might be ranked.

The four criteria were:

1. If everybody in this class had to live at school and two boys would be assigned to each room, choose your classmates in the order in which you would like to have them as roommates.

2. If your parents asked you to bring one of your classmates home with you to spend the weekend, choose the order in which you would ask your classmates to come home with you.

3. Choose the order in which you would most prefer to work with one of your classmates on a special school project.

4. Choose your classmates in the order from most to least that you would like to be friends with after school gets out this summer.

In accordance with Kendall's procedure (Kendall 1952), a general index of choice status was obtained by summing the ranks obtained by each student across the four criteria and ranking these scores.

The empathy, projection, and error scores were derived from the Inter-personal Check List (ICL) (Leary 1956), a 128 item questionnaire of the Yes - No type. In keeping with the foregoing procedure, the students filled out the ICL for themselves and for the teacher. The teachers also filled out the ICL for themselves, thus permitting the necessary comparisons to be made. The students were also instructed to indicate any item on the ICL which they did not fully understand. On the basis of these responses five of the items were eliminated from the analysis. Since items in the ICL vary in social acceptability with acceptable items occurring in the first half of the scale and negative ones in the second half, and since item acceptability relates to assignation of a characteristic to oneself, it was decided to analyze the two halves of the check list separately in addition to obtaining a total test score.

RESULTS AND DISCUSSION

Table 1 summarizes the basic data obtained. For purposes of analysis, the high and low 25 per cent in sociometric choice status for each class were selected and compared. It will be noted that 7 of the 8 independent comparisons for the empathy scores are in the predicted direction, and 6 of the 8 for disowning projection are also as hypothesized. On the other hand only 4 of the 8 for assimilative projection are as expected. Inspection of the error comparisons reveals one tie with the higher scores being associated with high choice status in 2 instances. The comparisons for the total ICL scores yield essentially similar information. All 4 scores are as predicted for empathy and disowning projection while only 2 of the 4 for assimilative projection are as expected. In 3 of the 4 error comparisons, the high scores are associated with low choice status. This balances the part scores and suggests a chance distribution as hypothesized. These observations would suggest support of the hypotheses relative to empathy, disowning projection and error; however correlative factors across some of the comparisons precluded the statistical testing of these inferences.

In order to assess the significance of these findings, the analysis of variance was applied where the assumption of variance homogeneity could be met. A classes by groups design with n measurements per cell was employed in all analyses. Heterogeneity was shown to exist in the empathy data for the second half of the ICL, and for all of the disowning projection data. Wilson's non-parametric test of analysis of

TABLE 1

MEAN AND STANDARD DEVIATIONS OF EMPATHY, ASSIMILATIVE PROJECTION, DISOWNING PROJECTION AND ERROR SCORES BY CHOICE STATUS, CLASSES, AND ICL BREAKDOWN

Choice Status on ICL		Grade 6 (N= 6)* 1st half	2nd half	Total	7 (N=8) 1st half	2nd half	Total	8 (N=6) 1st half	2nd half	Total	9 (N=8) 1st half	2nd half	Total
						EMPATHY							
High	Mn.	41.0	49.7	93.3	35.2	47.5	82.8	35.7	50.3	86.0	38.2	47.8	86.0
	SD	2.7	.9	11.7	8.7	3.0	8.4	1.2	12.0	16.8	5.7	2.4	6.7
Low	Mn.	40.7	36.7	89.3	30.5	39.5	70.0	30.3	50.7	81.0	36.0	44.2	80.2
	SD	2.1	7.3	12.6	11.9	14.8	17.2	6.1	4.2	11.2	8.0	2.3	6.3
						ASSIMILATIVE PROJECTION							
High	Mn.	12.0	6.7	18.7	13.2	9.2	22.5	18.0	9.7	27.7	12.5	12.5	25.0
	SD	1.7	3.6	4.9	6.2	2.6	7.9	4.6	3.5	6.4	3.5	3.0	6.5
Low	Mn.	11.0	5.7	16.3	14.2	12.5	26.7	20.0	7.0	27.0	16.5	11.2	27.8
	SD	7.2	3.5	9.1	7.7	8.9	4.3	6.2	4.0	2.7	5.0	2.6	6.8
						DISOWNING PROJECTION							
High	Mn.	2.0	3.0	5.0	1.5	4.5	6.0	3.3	5.7	9.0	2.0	1.0	3.0
	SD	0.0	2.6	2.6	0.6	4.5	4.8	2.5	5.0	7.0	1.7	0.0	1.7
Low	Mn.	5.4	6.3	11.7	3.0	10.2	13.2	5.7	4.0	9.7	1.8	4.2	6.0
	SD	4.2	6.1	10.3	1.2	9.5	10.4	2.5	2.0	2.1	0.5	2.5	2.4
						ERROR							
High	Mn.	6.7	6.0	0.7	15.2	11.0	1.8	4.7	4.3	0.3	10.2	8.2	2.0
	SD	1.2	1.6	0.5	3.8	4.1	0.8	1.7	1.9	0.5	4.8	4.0	1.7
Low	Mn.	6.7	4.7	2.0	11.5	10.0	1.5	6.3	4.7	1.7	10.0	6.8	3.2
	SD	6.7	3.4	1.4	6.5	8.0	1.1	0.5	0.9	1.2	3.4	3.4	2.3

*Half of the sample for each class is in the high choice group and half are in the low choice group.

variance which is distributed as chi-square (Wilson 1956) was thus computed for these 4 cases. Table 2 reveals that significance among the compared means was obtained for empathy on the second half of the ICL, assimilative projection on the total ICL, and for two of the disowning projection comparisons, while the third, that for the first half of the ICL, reached the .07 probability level. Inspection of Table 1 indicates that where significance was obtained the hypotheses were supported. Failure of the analyses of the error scores to attain significance suggests the validity of the hypothesis that this measure is independent of choice status. An exact test of this prediction is statistically not possible since it requires a proof of the null hypothesis.

TABLE 2

SIGNIFICANCE TESTS OF DIFFERENCES BETWEEN HIGH AND LOW CHOICE STATUS GROUPS

Variable	F-Ratio (df=1,20)	X^2(df=1)
Empathy		
ICL 1st half	1.38	
2nd half		3.85*
Total	3.31	
Assimilative Projection		
ICL 1st half	<1	
2nd half	<1	
Total	6.81**	
Disowning Projection		
ICL 1st half		3.40
2nd half		5.60**
Total		7.88**
Error		
ICL 1st half	<1	
2nd half	2.00	
Total	<1	

*Indicates significance at .05 level
**Indicates significance at .01 level

Even though not all of the hypotheses were substantiated, it is apparent that there is considerable reason to investigate further the concepts studied here. It should be noted that Cameron feels that assimilative projection has a utilitarian purpose in interpersonal relations in that it may enable an individual to save a great deal of time and energy by reducing the necessity of evaluating the motives and actions of others. In the present study, assimilative projection was regarded as

negatively related to adjustment. The results, however, make it unclear as to whether or not assimilative projection is maladaptive.

There is also the possibility that selection of the teacher as the referent may have tended to minimize the use of assimilative projection or empathy since both of these variables may from the student's viewpoint be more difficult to apply to the teacher, a very dissimilar person, than to a member of one's own group. It may also be that sociometric status will relate to empathy and projection more readily relative to representatives of one's own group rather than to a person who stands quite apart from, and possibly antithetic to the in-group. It is evident that the concepts employed here require not only consideration in terms of measurement as has been largely done in the past, but in terms of the theoretical bases for these derivations.

SUMMARY AND CONCLUSIONS

The present study represented an attempt to validate by an external criterion measures of empathy, assimilative, and disowning projection derived from objective questionnaire data by a new procedure.

Fifty-four school boys served as judges for their teachers in order to derive the empathy, assimilative projection, disowning projection and error data. Sociometric choices among the boys were also obtained, and those of high and low choice status were compared in relation to the formulated hypotheses.

Though there is some inconsistency in the findings, evidence is present to suggest that choice status relates positively to empathy, negatively to assimilative and disowning projection, and is independent of the error measure obtained. These results essentially support the hypotheses, but further evaluation is definitely indicated.

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ALTERNATION IN THE HUMAN STYLUS MAZE: TIME AND DISTANCE FACTORS

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Recent reviews (Dember and Fowler, 1958; Glanzer, 1958) of the literature on alternation behavior reveal that while there has been rather extensive experimentation with rats, few studies in this area have employed human Ss. Typically, the experiments with sub-human species have been concerned with the variables affecting alternation in maze choice-point behavior. Two published studies have investigated alternation in human maze behavior. Bitterman and Bretz (1946) found alternation at a maze choice-point which was preceded by one forced turn to establish the phenomenon with humans. Somewhat later, Thompson (1952) found that the number of forced turns preceding the choice-point was a relevant factor in this behavior. The present study was designed to further explore the variables of stylus maze alternation.

Time between forced turn and choice-point has been well established as a factor in the alternation behavior of sub-humans. A number of investigators (Grosslight and Ticknor, 1953; Lepley and Rice, 1952; Rice and Lawless, 1957) have reasoned, therefore, that as the distance between forced turn and choice-point was varied, running time between these turns would vary proportionately. Thus, where differential alternation behavior occured with various distances, the relevant variable was assumed to be the time between turns rather than the distance as such.

The present investigation seeks verification of differential alternation with varied distance between choice-point and forced turn, as well as, an analysis of the time-distance relationship in human stylus maze behavior.

METHOD

Subjects

Two-hundred and forty male and female students from the introductory course in psychology at the University of Kansas were assigned at random to eight groups employed in this experiment.

Apparatus

Six single-choice, grooved-type stylus maze variations were employed in this study. All mazes were identical in the following respects: the alleys were ¼-in. wide and ¼-in. deep, the distance from starting point to forced turn was 1 in., and the distance from choice-point to goals was

1 in. The mazes differed only in the distance between forced turn and choice-point and the direction of forced turn as follows:

R-T: maze alley lengths of ½-in., 1 in. and 2 in., respectively, between one forced 90 degree right turn and T choice-point.

L-T: maze alley lengths of ½-in., 1 in. and 2 in., respectively, between one forced 90 degree left turn and T choice-point.

A ¼-in. wooden dowel, 8 in. long and pointed on one end, served as a stylus.

Procedure

Thirty Ss were run through each of the six maze variations in the following manner: The maze was secured to a level table and covered with a black cloth. The S was seated at the table, then blindfolded. The maze was uncovered and the following instructions were read by *E*:

"This is a stylus maze problem. Hold the stylus as you would a pencil, but do not let your hand or arm rest on the table".

(The stylus was placed in S's hand and adjusted so that it was held about 1 in. above the pointed tip. The *E* then placed the point of the stylus at the starting point of the maze.)

"Here is the start. Slide the stylus along the groove until you reach the goal. Do not retrace your path and do not lift the stylus from the groove. Try to reach the goal as soon as possible. Ready, begin".

Each S was given one trial and dismissed. Direction of turn at the choice-point, either right or left, and time between forced turn and choice-point, which was measured with a stopwatch, were tabulated.

Two additional groups of 30 Ss each were run in the ½ in. from forced turn to choice-point mazes. One of these groups was given the forced left condition and the other the forced right condition. Procedure for these groups differed in that Ss were delayed approximately 3 sec. between the forced turn and the choice-point. The second paragraph of the instructions was modified for these groups in the following manner:

"Here is the start. Slide the stylus along the groove until you reach the goal. Do not retrace your path and do not lift the stylus from the groove. Before you reach the goal I will give you the signal to 'stop'. When I give the signal, stop where you are and wait until I say, 'proceed', then try to reach the goal as soon as possible. Ready, begin".

A block was placed at the choice-point to insure the delay between forced turn and choice-point. After the 3 sec. delay, the block was removed and *E* said, "Proceed".

In all other respects the procedure was identical to that previously described for the other six groups.

RESULTS

Table 1 indicates the number of Ss turning in each direction at the choice-point in each of the eight maze conditions. An *alternation* is defined as turning in the direction opposite to that of the preceeding

forced turn. A *repetition* is defined as turning in the same direction as the preceeding forced turn.

Chi-squares were computed to determine whether or not the data of the forced right and forced left variations of the mazes could be pooled. Since none of these chi-squares were significant, the differences between the forced turn direction variations were assumed to be no greater than expected in random sampling from a common population. This finding permitted pooling the data of the forced turn direction variations, providing an N of 60 in each of four major maze variations. These pooled data, shown under the Total column of Table 1, were then subjected to further statistical analysis.

TABLE 1

DIRECTION OF TURN AT THE CHOICE-POINT

	R-T		L-T		Total	
Maze	Left	Right	Right	Left	Alternation	Repetition
2 in.	15	15	14	16	29	31
1 in.	19	11	18	12	37	23
½-in.	22	8	23	7	45	15
½-in. (delay)	21	9	21	9	42	18

Testing the hypothesis that the three standard distance variations (excluding the ½-in. delay group) were drawn from a common population, obtained a chi-square value of 9.00 which is significant at less than the .02 level for 2 degrees of freedom. Testing the hypothesis that the standard ½-in. group and the ½-in. delay group were drawn from a common population, obtained a non-significant chi-square value. It was therefore concluded that while distance between forced turn and choice-point is a relevant variable in alternation behavior, the 3 sec. delay for the ½-in. distance was not.

Table 2 indicates the mean times between forced turn and choice-point for each of the four major maze conditions. It is evident that under the standard conditions, as distance between turns increases, time between turns also increases. However, if time between turns is a relevant variable in alternation behavior, one would expect the *Ss* who take less time between turns to show more alternation than *Ss* who take a longer time. Stated another way, it would be expected that the mean time between turns would be less for *Ss* who alternated at the choice-point than for those who did not. The results of this study do not support this hypothesis. Differences between mean alternation and repetition times for each of the four major maze conditions were found to be no greater than expected from random sampling of a common population as revealed by *t* tests..

Testing the hypothesis that the times for the standard ½-in. group and the ½-in. delay group were drawn from a common population, ob-

TABLE 2

MEAN TIMES BETWEEN TURNS

Maze	Alternation	Repetition
2 in.	3.1	3.8
1 in.	3.5	3.3
½-in.	.7	.8
½-in. (delay)	4.0	3.5
Grand Mean	2.8	2.8

tained a t value of 3.60 which is significant at less than the .01 level for 118 degrees of freedom. Thus, it was concluded that the mean time of the ½-in. delay group was significantly greater than the mean time of the standard ½-in. group.

DISCUSSION

The findings of this study indicate that while distance between forced turn and choice-point is a relevant variable in alternation behavior, time is not. Mean times of *Ss* making a repetition at the choice-point were no greater than *Ss* making an alternation at the choice-point. The hypothesis that time is not a relevant variable is given further support by comparison of the standard ½-in. group and the ½-in. delay group. Although the mean time between turns of the ½-in. delay group was significantly greater than the standard ½-in. group, there was no significant difference in alternation behavior.

No definite conclusions regarding the role of the time variable in alternation behavior in the human stylus maze should be made on the basis of the present study. Needless to say, the times involved were very brief. Further experimentation with a wider range of times would clarify the role it plays in this behavior. If one generalizes from the findings of the studies with sub-human *Ss*, one would assume that in all probability it does influence alternation at some point.

The most important finding of the present study was not that time had no influence, but that distance, as such, did. At least with human *Ss* the form of the maze itself is an important factor. The results of this study indicate that one is not justified in assuming that the underlying relevant variable is time when differential alternation is obtained with varied distances between turns.

SUMMARY

The present study was designed to investigate the time-distance

relationship in alternation behavior in the human stylus maze. Two-hundred and forty *Ss* were run in four major maze variations. Within this study it was found that distance, not time, was the relevant variable in alternation behavior.

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EXTENDED UNPACED AND PACED WORK ON THE PURSUIT ROTOR

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A study done some years ago by the present investigator employed two psychomotor tests: the rotary pursuit apparatus and the complex coordination test (Nance, 1947).

The earlier study employed the hypothesis that the correlations among motor abilities (typically low up to that time) might be increased by the manipulation of certain procedural variables. Four hundred college age men were tested in pairs. Two variables were studied: the well investigated factor of distribution and the less frequently studied factor of pacing.

In a test of motor coordination, when the apparatus has some built-in "speed" factor, it becomes the task of *S* to adapt himself to this speed or rhythm, and the score which he earns is a measure of the extent to which he is successful in doing this. Where the apparatus possesses no such characteristic, *S* is able to work at his own rate and thus, to some extent at least, paces the work himself and controls the rate at which the apparatus operates. These conditions may be referred to as "paced" and "unpaced" work respectively.[1]

The pursuit rotor had traditionally been used as a paced test and the complex coordinator as an unpaced test. Both pieces of apparatus were modified in such a way as to provide for paced and unpaced work.

The results obtained from the study did not substantiate the hypothesis of increased intercorrelation. Coefficients ranged from .06 to .56, averaging about .40. Another finding in the earlier study was that the curves for unpaced work, particularly with the pursuit rotor, were relatively flat, leading to the conclusion that little if any actual learning took place during the testing period. It was assumed at the time that the four-minute work period might have been too short to enable any appreciable amount of learning to show itself. (It was known that four minutes of practice was sufficient to produce considerable change in performance with the *paced* pursuit rotor, especially if the practice was distributed.)

It was the purpose of the present study: (a) to determine whether larger amounts of practice would lead to improved performance on the

[1] Alternative terms might be "apparatus-paced" and "subject-paced." Nystrom, Morin, and Grant (1955) use the terms "automatically-paced" and "self-paced" respectively. Ammons et al (1958) use the term "compensatory pursuit skill" in a way somewhat related to that in which the term "unpaced" is used here.

unpaced pursuit rotor, (b) to explore further the interaction between distribution and pacing, (c) to determine whether male and female Ss differed in their performance, (d) to determine what, if anything, happened to the variability in the scores, and (e) to compare unpaced with paced work using this particular apparatus.

METHOD

A simple form of the pursuit rotor apparatus was used in the present study, a different model from that used before. The present apparatus used a black, masonite turntable, 12 inches in diameter. A silver target, three-fourths of an inch in diameter, was flush with the surface. The center of the target was one inch from the outside of the turntable. The stylus used by S was 10 inches long and bent easily in the middle. Its tip was four and a half *mm* across. The smooth handle allowed S to maintain a comfortable grip.

This apparatus was placed on a table approximately 30 inches high. Ss stood during the entire period. During paced work, the speed of the turntable was constant, 60 *rpm*. During unpaced work, its speed was irregular and depended upon the amount of time S was able to maintain contact with the target. In unpaced work, whenever S was able to stay on the target for an appreciable amount of unbroken time, the turntable attained a speed of 60 *rpm*.

Two Standard Electric S-1 clocks, calibrated in hundredths of a second, were used. A switching arrangement made it possible to use the clocks alternately in successive trials of massed practice. Work and rest periods were timed and the two clocks were activated alternately by the use of two Hunter Decade Interval Timers, model 111B.

One hundred forty Ss, 69 men and 71 women, were used. Students were informed of the policy requiring them to spend time serving as Ss in departmental experiments. They were further told that they would be given "a few points" for serving. Thus, those who participated were, in a sense, volunteers.

Ss were tested singly by either the investigator or one of two student assistants.[2] They were assigned to a particular *E* "at random."

A general explanation of the apparatus was given to S. The proper holding of the stylus was demonstrated. No advance practice was permitted. In all cases, it was indicated that S was to keep the tip of the stylus in contact with the target as much of the time as possible.

Each S was assigned to one of four groups: (a) distributed-paced, (b) massed-paced, (c) distributed-unpaced, or (d) massed-unpaced in a chance order, with a view to keeping the groups approximately equal both as regards totals and as regards the distribution of men and women.

[2] Student assistants were Duane Schwahn and David Edwards.

TABLE 1

MEAN PER CENT TIME ON TARGET
BY MINUTES OF WORK
(PURSUIT ROTOR)

	N	1	2	3	4	5	6	7	8	9	10
		Paced									
Men, Distributed	(16)	3	7	10	14	15	17	20	20	23	24
Men, Massed	(17)	3	5	6	6	7	11	11	10	12	11
Women, Distributed	(18)	2	3	4	6	7	8	9	11	13	14
Women, Massed	(18)	1	2	3	3	3	6	6	7	7	6
		Unpaced									
Men, Distributed	(16)	35	38	37	37	37	36	36	36	36	36
Men, Massed	(18)	34	34	34	33	33	34	33	32	32	31
Women, Distributed	(18)	37	38	37	36	36	36	36	35	35	35
Women, Massed	(19)	34	34	34	32	33	34	32	32	31	30

All Ss were given 10 minutes of work. Distributed practice consisted of 40 trials of 15 seconds each, alternated with rest periods of the same length. Massed practice consisted of two blocks of practice of five minutes each, with a rest period of one minute between. With paced work, the turnable revolved continuously at a constant speed. During rest periods, S let the tip of the stylus rest lightly on the center of the turntable.

Ss were given a general indication as to the nature of the work and rest periods. Work was started and stopped at an oral signal from *E*.

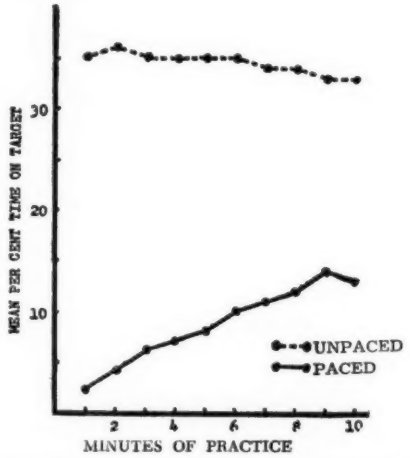

Fig. 1. Pursuit rotor scores (male and female, massed and distributed, combined) for paced (N equal 71) and unpaced (N equal 69) work.

RESULTS

An obvious aspect of the data obtained in this study was the failure of Ss doing unpaced work to show improvement during the course of their practice. Inasmuch as it is easy for Ss to maintain some contact with the target in this condition, initial scores were high (see Table 1). For all unpaced groups, however, the performance curves were quite flat. For both men and women, distributed practice yielded slightly higher scores than massed practice. Men scored slightly higher than women.

With paced work, rather conventional curves were obtained. By the end of five minutes, scores were approximately twice as good for distributed as for massed practice. This was true for both men and women. This approximately *two* to *one* ratio was maintained during the second five minutes of work. This, also, was true for both men and women. In both massed and distributed practice, men did almost twice as well as women. (see Fig. 1)

It would appear that, despite a superficial similarity, the paced pursuit rotor and the unpaced pursuit rotor represent quite different tasks. The failure of Ss to show any particular improvement in unpaced work is puzzling but is more or less consistent with the earlier results. Despite the fact that more than twice as much practice was given in this task as had previously been the case, learning (a rise in the performance curves) failed to appear.

In order to compare the two kinds of work in another way, *SD*s of time on the target for the first minute of practice and for the last minute of practice were obtained for all conditions of work (see Table 2).

TABLE 2

STANDARD DEVIATIONS FOR FIRST AND LAST MINUTES OF WORK (PURSUIT ROTOR)

	N	First	Last
		Paced	
Men, Distributed	(16)	1.63	5.93
Men, Massed	(17)	3.53	4.82
Women, Distributed	(18)	1.66	6.42
Women, Massed	(18)	.51	3.40
		Unpaced	
Men, Distributed	(16)	1.56	1.58
Men, Massed	(18)	2.14	1.51
Women, Distributed	(18)	1.81	1.39
Women, Massed	(19)	1.40	1.36

In this case also, a striking difference between paced and unpaced work was obtained. In all paced work conditions, *SD*s increased, the ratio between the last minute of work and the first minute of work being almost *three* to *one*. The men with massed practice showed this tendency the least. This group, however, showed an initially large spread.

In unpaced work, *SD*s showed a tendency to decrease a little. The most pronounced example of this was in massed practice for men. This particular group showed the highest initial *SD*, as was the case for the men with massed paced work.

This tendency for individual differences in performance to increase with practice in paced work and for the reverse to be true in unpaced work is another indication of an important difference between the two kinds of performance.

DISCUSSION

Various explanations were considered as to why Ss almost uniformly failed to show improvements in unpaced work. There were numerous differences in scores from S to S and from trial to trial for the same S, but when scores for individuals were combined, these trial to trial differences tended to disappear.

There was nothing inherent in the apparatus as used in the unpaced condition which prevented Ss from improving. The investigator and a student assistant were able to obtain scores which were considerably higher than those made by the Ss.

An explanation of the results might lie in a lack of motivation in Ss doing unpaced work. There was no *apparent* lack of motivation on their part, however, and there was no reason to assume that they were inferior in this respect to Ss doing paced work.

A likely explanation is that Ss to some extent misinterpreted the nature of the task. The instructions merely indicated that they were to maintain contact with the target as much of the time as possible. Perhaps they interpreted the test simply as a work task rather than one involving progressive improvement. Apparently Ss doing paced work approached their task in a somewhat more vigorous and competitive manner. The problem of maintaining contact with the constantly moving target was obviously a difficult one.

It seems quite possible that time on the target is an inadequate measure for unpaced work. It is possible that number of revolutions of the turntable would be a better measure of S's skill.

We may conclude that: (a) the flatness of the curves in the earlier study with unpaced work was not due to an insufficient amount of practice, (b) removing the pacing factor from the pursuit rotor radically changes the nature of the task, (c) as understood so far at least, re-

moval of the pacing factor leads to initially higher scores, reduces the difference between distributed and massed practice, reduces the difference between the scores of men and women, and leads to flatter performance curves.

It would appear desirable to explore the factor of social influence in unpaced work, the transfer effects between paced and unpaced work, the effect of more explicit instructions and demonstrations on unpaced work, and the effect of changed methods of scoring with unpaced work (e.g., scoring for revolutions of the turntable instead of time on the target).

SUMMARY

One hundred forty Ss, 69 men and 71 women were used in the present experiment. Approximately equal numbers were used for paced and unpaced work and for massed and distributed practice.

The main purposes of the experiment were: (a) to determine the nature of the performance curves for unpaced work when larger amounts of practice were used than had been the case heretofore, (b) to explore further the interaction between distribution and pacing, and (c) to determine whether the same effects held for women as for men.

Results indicated that removing the pacing factor led to initially high scores, flat performance curves, a decrease in the difference between distributed and massed practice, a decrease in the difference between scores for men and women, and the elimination of the spreading out of individual scores characteristic of paced work.

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ON THE ACCURACY OF WRITTEN RECALL; A SCALING AND FACTOR ANALYTIC STUDY[1]

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A persistent methodological difficulty in the study of connected meaningful material, such as prose and poetry, is a rationally based system of measuring the accuracy of recall. The measures that are used, such as the number of idea groups or the number of identical words, are usually justified in terms of face validity or at best the contrasted groups method of validation is used. In the contrasted groups method, the measure in question is shown to differentiate among various levels of training. As is well known, this is a rather insensitive method of validation.

The present experiments demonstrate a method for establishing the empirical validity of various scoring procedures utilizing scaled scores as criteria. Factor analytic treatment of the various intercorrelations among the scoring procedures will be utilized in an attempt to reduce and identify the number of variables of importance in the accuracy of recall.

EXPERIMENT I

The Stimuli

The stimuli utilized in this experiment consisted of two short stories, the first being Bartlett's well known *War of the Ghosts* (Bartlett, 1932) and a second story called *Who Shall Go* which was written by the present author. The second story is a 221 word science fiction story which is concerned with the problem of who shall be the first to go aloft in the spaceships or satellites.

Experimental Procedure

In the recall phase of this experiment, four groups, of fifteen females each, recalled one of the above mentioned stories. The Ss, who were all psychology students at The American University, were told that the *E* would read a story and wanted them to listen carefully and that after the reading they would be asked to write the story, on paper provided, as nearly like the original as possible. In group A the story *Who Shall Go* was read once, in group B the same story was read twice, in group C the *War of the Ghosts* was read once, and in group D the *War of the Ghosts* was read twice. The *Ss* were given unlimited time to write their recalls.

[1] This investigation was supported by a research grant M-3174(A) from the National Institute of Mental Health, United States Public Health Service. The author is indebted to Drs. Charles N. Cofer of New York University and James Deese of John Hopkins University for their interest and for their critical reading of the manuscript. Dr. Deese suggested the factor analytic treatment and performed the analyses presented in Table 5.

The *E* then typed the recall of each S on a 5 by 8 white card. All errors in spelling, punctuation, etc. were retained. The final result of this procedure was four sets of fifteen recalls which were the basic data for the study.

Scoring Procedure

The next step in the analysis was to score the various sets of recalls for their accuracy in comparison to the original learning material. All of the scoring, except for the criterion scores, was done by the author. It should be noted that all methods of scoring for accuracy of recall were completed before the calculation of the criterion values based on the results of scaling. The following methods of scoring for accuracy of recall were utilized.

Idea Group. The idea unit is perhaps the most common of all methods of scoring the accuracy of recall of connected meaningful material. There were forty-eight such arbitrary units in the story *Who Shall Go* and eighty-two in the story *War of the Ghosts.* To be counted as present the essentials of the idea had to be present in the recall, although direct word for word similarity was not required. There was no penalty given for the recalled material being out of sequence with respect to the original material.

Cloze Procedure. This is a variation of a technique that has been developed by Taylor (1953). The present use of this technique consisted in eliminating every tenth word, unless the word were an article or conjunction, from the original story and then seeing if the missing word could be filled in by referring to the recalls of the original. There were twenty-one blanks in the story *Who Shall Go* and thirty-one blanks in the *War of the Ghosts.* To be considered as present in the recall, the word had to be identical, except for minor spelling variations, to the word eliminated.

Number of Sentences. This was simply the number of sentences present in the recall. Punctuation as used by the Ss was utilized as criterion.

Content Words. In this procedure, all of the form words, i.e., articles, conjunctions, prepositions, etc., were eliminated from the original story and the recalls were checked to determine the presence of the remaining content words. To be considered as present in the recall the word had to be exactly as given on the original, except, again, for minor spelling variations. No penalty was given for sequence errors or for the presence of words not in the original story. There was also no check-off system so that a recall might have the word "space" present four times and the original story only have the word three times, but credit was given for four words recalled.

Total Number of Words. This was simply the total number of words that the S wrote on a recall.

Identical Words. This was the same as content words except that all words, both form and content, were utilized in the scoring. All the conditions of scoring mentioned in content words also apply to the similar words system.

Criterion Scores. Each set of recalls was scaled according to the method of rank order. The general outline of the procedure may be found in Guilford (1954). Guilford's common C scale was utilized as a transformation from z values. Twenty students and colleagues ranked all four sets of recalls, the time taken for ranking was from forty-five to ninety minutes. No specific criteria other than comparison to the original story in terms of excellence of recall were given. The order in which the stories were ranked varied from individual to individual. As each judge in the ranking group ranked each story it was possible to obtain a measure of reliability of the ranking. The judges were randomly divided into two groups of ten each and the recalls of each set were scaled according to the two groups of ten rankers. Thus, in addition to the scaled scores based on twenty judges, each set of recalls had two sets of scaled scores, based on ten judges each, which could be correlated to present an indication of the reliability of the ranking.

In summary then, each of the fifteen recalls of the four groups were scored for accuracy by the above seven procedures.

RESULTS AND DISCUSSION

The Correlation Matrices. All of the twenty-one intercorrelations among the seven scoring systems were calculated for each of the four groups of recalls. The results are presented in Tables 1 through 4. The *rr* term associated with each matrix is the reliability of the scaled criterion scores calculated according to the method previously discussed. The reliability coefficients have been corrected by the Spearman-Brown formula. The variables are identified by number in Table 1 and this identification is utilized throughout the remainder of the paper.

TABLE 1

CORRELATION MATRIX FOR THE RECALLS OF GROUP A

	2	3	4	5	6	7	1
2. Idea Group	—	.402	.816	.814	.880	.894	.807
3. Cloze Procedure		—	.248	.492	.271	.457	.498
4. Number of Sentences			—	.636	.831	.840	.651
5. Content Words				—	.613	.704	.607
6. Total Number of Words					—	.966	.837
7. Identical Words						—	.819
1. Criterion (Scaled Scores)		rr=.963					—

TABLE 2

CORRELATION MATRIX FOR THE RECALLS OF GROUP B

	2	3	4	5	6	7	1
2	–	.741	.447	.836	.639	.718	.699
3		–	.464	.754	.283	.431	.387
4			–	.649	.504	.580	.493
5				–	.731	.843	.720
6					–	.961	.845
7						–	.844
1	$r_r = .879$						–

TABLE 3

CORRELATION MATRIX FOR THE RECALLS OF GROUP C

	2	3	4	5	6	7	1
2	–	.419	.682	.802	.764	.877	.882
3		–	.419	.544	.559	.624	.721
4			–	.712	.775	.770	.836
5				–	.582	.754	.872
6					–	.958	.772
7						–	.844
1	$r_r = .983$						

TABLE 4

CORRELATION MATRIX FOR THE RECALLS OF GROUP D

	2	3	4	5	6	7	1
2	–	.803	.301	.745	.736	.815	.856
3		–	.035	.842	.374	.566	.705
4			–	.344	.445	.455	.407
5				–	.344	.580	.798
6					–	.944	.692
7						–	.840
1	$r_r = .951$						–

Several points are apparent from observation of the matrices. First, several of the variables, such as total number of words and idea group, have rather high correlations, in most matrices, with the criterion scores which would indicate that, within the conditions of the experiment, these scores give adequate measures of accuracy of recall, providing, of course,

that the scaled scores be accepted as adequate criterion. It should also be noted that the intercorrelations among the six non-criterion variables are rather high. The average of the fifteen non-criterion intercorrelations in the recalls of groups A, B, C, and D were .731, .686, .721, and .617 respectively. Finally, it is seen that the reliability of the criterion scores drops as the degree of learning increases, i.e., as the story is presented twice rather than once. This drop in reliability seems logical, in that increasing the learning would decrease the individual differences in recall as there is an upper limit of learning in this activity. As the judges in the scaling study utilized individual differences to rank the recalls, the smaller individual differences should make consistant ranking more difficult and hence a drop in reliability would be expected. Of course, it should be pointed out that the drop in reliability was not so great as to discredit the use of the criterion. The lowest reliability was still .879.

Factor Matrices. In an attempt to present a more parsimonious view of the results, the four correlation matrices were subjected to factor analysis. The solution was by the centroid method and variables six, seven, and one were reflected for the first factor residuals. This was a decision made in light of the first analysis which was done on Group B. All analyses were done with this reflection. After the second factor loadings were obtained, the solution was rotated through 45 degrees and the second factor reflected. The second factor residuals were practically all negligible. Table 5 presents the factor matrices derived from the previously presented correlation matrices. Observation of the factor loadings seem to suggest that F1 is best identified with the content words

TABLE 5

FACTOR MATRICES
GROUPS

	A		B		C		D	
Tests	F1	F2	F1	F2	F1	F2	F1	F2
2.	.724	.612	.749	.461	.576	.666	.720	.578
3.	.482	.214	.874	.064	.397	.541	.811	.249
4.	.586	.594	.564	.368	.465	.713	.207	.413
5.	.866	.266	.818	.506	.963	.241	.958	.184
6.	.403	.897	.265	.947	.317	.941	.206	.932
7.	.575	.795	.426	.888	.596	.758	.385	.921
1.	.504	.722	.380	.808	.645	.715	.624	.624

variable. The cloze procedure is also highly loaded in this factor, at least in the factor matrices obtained from the recall of groups B and D. As both B and D were the groups of *Ss* who had the stories read twice, this suggests that the cloze technique becomes more effective or representative as a measure of this factor as the degree of learning increases. The second factor, F2, is clearly a number of words factor, the best estimate of this factor being simply the total number of words produced.

If the variables that are best representative of each factor, content words for F1 and total number of words for F2, account for most of the variability in predicting accuracy, then the multiple correlation between these two variables and the criterion scores should be high. Table 6 presents the corrected multiple correlation coefficients between the criterion and the best combination of content words and total number of words. The regression equations for predicting the criterion scores from the above mentioned two variables are also presented in Table 6. As can be seen from the regression equations, there appear to be more differences

TABLE 6

REGRESSION EQUATIONS AND CORRECTED MULTIPLE CORRELATION COEFFICIENTS FOR ALL GROUPS RELATING THE CRITERION SCORES TO THE CONTENT WORDS AND THE TOTAL NUMBER OF WORDS

		cR1.56	Regression Equations
Groups	A	.817	$X' = -.248 + .045X_5 + .043X_6$
	B	.832	$X' = -.845 + .031X_5 + .035X_6$
	C	.919	$X' = -1.291 + .064X_5 + .016X_6$
	D	.893	$X' = -3.334 + .060X_5 + .022X_6$

between stories than there are differences between degrees of learning of the same story. This difference can be made clearer by the following procedure: If Beta weights B15.6 and B16.5 are multiplied by r15 and r16 respectively, the products will indicate the relative contribution of the independent variables to the total predicted variance of the criterion. The results of this procedure are presented in Table 7. It should be noted that the sum of the two products in any group does not equal the square of the cR1.56, but it does equal the square of the uncorrected multiple correlation coefficient. Again, Table 7 clearly illustrates the greater similarity between two degrees of learning of the same story as contrasted

TABLE 7

THE RELATIVE CONTRIBUTION OF THE TWO INDEPENDENT VARIABLES TO THE CRITERION

Group	Content Words	Total Words
A	.091	.624
B	.158	.575
C	.557	.309
D	.507	.328

to a different story. For the story *Who Shall Go,* the total number of words is by far the most important factor. In the *War of the Ghosts* the relative importance of the two factors is reversed although not to such a great degree.

There are, of course, many ways in which the two stories differ. Perhaps the most obvious difference is the length of the stories, with the *War of the Ghosts* being 332 words in length which contrasts to the *Who Shall Go* which is only 221 words in length. In Experiment II, an attempt is made to determine the influence of length.

EXPERIMENT II

The Stimuli

The stimuli utilized in this experiment also consisted of two short stories. The first story was Bartlett's *War of the Ghosts,* shortened to 208 words to be similar in length to *Who Shall Go* utilized in Experiment I. The second story was 388 words in length and was a summary of the mental health film on ethnic prejudice, *The High Wall.* For those familiar with the film, is should be noted that the present story did not present the alternative outcomes contained in the film.

Experimental and Scoring Procedure

In this experiment, two groups, of fifteen females each, recalled one of the above mentioned stories. The *Ss* were all psychology students at The American University. The general experimental procedure was the same as in Experiment I except that there was no collection of data for more than one reading of the stimulus materials. Those Ss who had the shortened *War of the Ghosts* read once were designated group E and those *Ss* who had *The High Wall* read once were designated group F. The scoring procedure for the recalls was exactly the same as outlined in Experiment I. Of course, there were differences in terms of the number of idea groups and cloze blanks used. In the short *War of the Ghosts* there were 75 idea groups and 21 cloze blanks, while in *The High Wall* there were 97 idea groups and 36 cloze blanks. The outcome of these steps resulted in each of the fifteen recalls of the two groups being scored for accuracy by the previously mentioned seven procedures.

RESULTS AND DISCUSSIONS

The Correlation Matrices. The same values that were described in Experiment I under correlation matrices were also calculated on the results of the recalls of groups E and F. The results are presented in Tables 8 and 9. The identification of the variables is the same as in Table 1. As was true in Tables 1 through 4, there are several variables which correlate rather highly with the criterion. The reliability of the criterion scores leaves little to be desired. Perhaps the most immediately outstanding feature of the two Tables is the very high correlations found in Table 8. The average of the fifteen non-criterion intercorrelations in

TABLE 8

CORRELATION MATRIX FOR THE RECALLS OF GROUP E

	2	3	4	5	6	7	1
2	—	.870	.647	.910	.932	.946	.954
3		—	.681	.877	.811	.810	.862
4			—	.773	.696	.696	.647
5				—	.908	.912	.897
6					—	.982	.916
7						—	.929
1	rr = .981						—

TABLE 9

CORRELATION MATRIX FOR THE RECALLS OF GROUP F

	2	3	4	5	6	7	1
2	—	.599	.894	.819	.737	.838	.857
3		—	.678	.744	.428	.555	.706
4			—	.790	.674	.784	.745
5				—	.579	.726	.672
6					—	.971	.752
7						—	.812
1	rr = .978						—

TABLE 10

FACTOR MATRICES

GROUPS

	E		F	
	F1	F2	F1	F2
2.	.637	.723	.709	.604
3.	.754	.513	.722	.316
4.	.668	.407	.785	.486
5.	.771	.583	.835	.364
6.	.545	.818	.267	.924
7.	.550	.819	.410	.908
1.	.585	.762	.581	.676

Table 8 is .864, which contrasts to an average non-criterion intercorrelations of .761 in Table 9. It will be recalled that these intercorrelations ranged from .617 to .731 in Experiment I.

Factor Matrices. The correlation matrices presented in Tables 8 and 9 were subjected to the same factor analytic procedure that was outlined in Experiment I. Table 10 presents the factor matrices derived from the above correlated Tables. Observation of the factor loadings again, at least in Group F, seem to identify content words with F1 and the total number of words with F2. This general idea also seems to fit with the results of group E. However, if the factor loadings obtained in group E are plotted, it will be seen that there is considerable doubt as to the justification of two factors, or if the two factors be granted, then they are highly correlated.

The corrected multiple correlation coefficients between the criterion and the best combination of content words and the total number of words were .868 and .769 for groups E and F respectively. The two regression equations for predicting the criterion variables for groups E and F respectively were;

$$X'_1 = -.221 + .058X_5 + .024X_6$$
$$X'_1 = -.650 + .033X_5 + .023X_6$$

Table 11 presents the products of the Beta weights times the correlation

TABLE 11

THE RELATIVE CONTRIBUTION OF THE TWO INDEPENDENT VARIABLES TO THE CRITERION

Group	Content Words	Total Words
E	.334	.454
F	.239	.411

coefficients which indicate the relative contribution of the independent variables to the total predicted variance of the criterion. In both groups, the total number of words seems slightly more important.

In general it may be concluded that, with the possible exception of the recalls of group E, and within the scoring systems and stories utilized, there are two factors involved in determining the accuracy of written recall of connected meaningful material. These two factors are the number of content words reproduced and the quantity of the words produced. There also seems to be the possibility that the cloze procedure method tends to become representative or typical of F1 as the degree of learning increases, although there is, as yet, obviously not enough evidence on this point. It may also be possible that the length of the original learning material will affect the number of factors obtained. The two factors of the recalls of group E, which had received the shortest

stimulus story, seemed to be about to collapse into one factor. On the other hand the recalls of group A were based on a story only thirteen words longer than the story used by group E, although it did have a different subject matter, and the two factor nature of A is clear. Thus if length is important it has to be considered with respect to the subject material of the story. The factorial structure of recall will then be a function of the interaction between length of learning material and subject matter of the learning material. At present, of course, this must be considered a tentative hypothesis. Research is being undertaken to help clarify this point.

In addition to utilizing this methodology for the purpose of measuring the accuracy of recall, the factor loadings might be used as dependent variables. Thus, the relationships between different types of material and stages of mastery could be described in terms of a shift in factor loadings. For example, perhaps the correlation between two sets of factor loadings could be utilized as a measure of the degree of similarity of the two stories.

SUMMARY

Six sets of recalls of stories were scored for accuracy by seven different methods, including the scaling of recalls by the method of rank order. The six correlation matrices derived from the above procedure were subjected to factor analysis. In all cases, with perhaps one exception, two factors emerged which were identified as the number of content words reproduced and the total number of words produced.

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MONOCULAR CONTOUR PERCEPTION UNDER THE INFLUENCE OF PRIOR STIMULATION OF THE CONTRALATERAL EYE[1]

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When the visual system provides clear definition of the boundary of a stimulus object seen in the visual field, then contour perception has occurred. The manner in which the eye and proximal neural structures make out a clearly defined boundary from varying patterns of light energy falling upon the retina is not understood very well. It is clear, however, that when the eye looks upon a small dark square viewed against a lighter background there is no apparent gradient of gray where the dark square meets the background. Instead, assuming adequate illumination, the boundaries of the stimulus object are seen clearly contoured. The importance of an understanding of the mechanisms responsible for contour perception is obvious; and yet the matter of contour perception has received very little attention.

It has been demonstrated (Smith and Gulick, 1956, 1957) that the perception of the contour of a moving stimulus is influenced to an important degree by the visual events preceding stimulus movement. The edges of a small stimulus object which are not seen as clearly contoured at a particular velocity can be observed at that velocity *provided* that the stimulus object is presented in a stationary position for a brief duration before its movement. Moreover, data from another experiment (Gulick, 1959) indicate that the perception of the contour of a moving stimulus is influenced not only by the duration of the stationary stimulus, but by its location in the visual field relative to the place from which movement begins.

In these experiments dealing with the perception of the contours of stimuli in motion, the duration of the stationary stimulus (T) and the maximum velocity (V) at which contour could be resolved during subsequent movement have been found to be related linearly. The phenomenon of contour facilitation has been studied under conditions wherein T ranged from 0 to 300 msec and V ranged from 0 to 30° visual angle per sec.

A tentative explanation of contour facilitation under the conditions of stimulation described was offered within the framework of the statistical model of visual activity (Smith and Gulick, 1957; Gulick, 1959). It

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was suggested that neural activity in the visual cortex following the cessation of the stationary stimulus summed with the activity produced by the moving stimulus. The effect of the summation was to maintain the total level of neural excitation at a level sufficiently different from that of the surrounding cortical areas so as to meet the necessary conditions for contour perception. The perception of contour of the moving stimulus was considered to be dependent upon the summation of neural excitation in the visual cortex from the two phases of the stimulation sequence.

Since experimentation on this phenomenon has always been conducted under conditions of binocular viewing, no data are available to indicate the efficiency of the visual system in resolving contour under conditions of monocular stimulation. One purpose of the present experiment was to obtain data on contour facilitation under both binocular and monocular conditions so that they might be compared. Such a comparison might allow us to refine the theoretical explanation of contour facilitation.

The second purpose of the present experiment was to observe contour facilitation under conditions wherein the stationary stimulus was presented to one eye and the moving stimulus to the other. In this manner, the entire visual system would be involved, but not simultaneously. If it could be shown that the stimulation of one eye could influence the perception of contour involving the contralateral eye *at a later moment*, then such a demonstration could be taken as rather dramatic proof of the integrating capacity of the visual system.

METHOD

Observers. Eight trained *O*s between the ages of 17 and 27 years made contour judgments. Each *O* met a visual acuity criterion of 1.0, corrected, for each eye. Although all *O*s were naive about the purpose of the present experiment, each one had participated in other experiments involving contour judgment.

Apparatus. A white disc with a diameter of 66 cm was rotated on a horizontal axis such that the plane of the disc was perpendicular to *O*'s line of sight. A white rectangular shield placed in front of the disc in a parallel plane occluded the entire disc except for the portion which was visible to *O* through a small rectangular aperture that subtended a visual angle of 9.0° in width and 0.5° in height. The stationary stimulus was produced by a 90° concentric arc painted in flat black upon the surface of the disc. The moving stimulus was produced by a 60° eccentric arc. The velocity of the moving stimulus was varied by changing the speed of rotation and the duration of the stationary stimulus was varied by speed of rotation and/or by occluding part of the 90° concentric arc with a white sector superimposed on a disc. The direction of rotation was counterclockwise: movement was from left to right. Each stimulus subtended a visual angle of 0.5° in height and width, and movement ex-

tended through a visual angle of 5.0°. The stationary stimulus appeared as a square. Due to the "fall" of the eccentric arc, the moving stimulus appeared to *O* as a parallelogram with its right and left edges displaced several degrees from vertical.

A reduction screen placed midway between the disc and *O* limited the total visual field to a width of 16° visual angle and a height of 5°. An adaptation panel located immediately behind the reduction screen was used both to interrupt *O*'s vision between trials and to maintain a constant level of visual stimulation throughout the experiment. The brightness of this panel and the white shield and disc equalled 70 ft-l, and the brightness of the stimuli equalled 2 ft-l, as measured with a Macbeth illuminometer.

During monocular viewing *O* wore an opaque patch over his non-preferred eye. Presentation of the stationary stimulus to one eye and the moving stimulus to the other eye was accomplished with an irregular truncated wedge with its base in the fronto-parallel plane immediately in front of *O* and its theoretical apex toward the disc and in *O*'s line of sight. With the wedge in place *O*'s right eye could see only that portion of the visual field in which the moving stimulus appeared, and *O*'s left eye could see only that portion of the visual field in which the stationary stimulus appeared. The wedge was painted flat black. Figure 1 illustrates the important components of the apparatus. Other descriptive detail of the apparatus has appeared elsewhere (Gulick, 1959).[2]

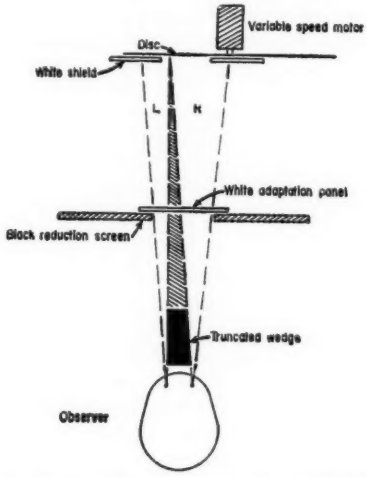

Figure 1. The arrangement of apparatus used to present the stimulation sequence to *O*. The truncated wedge used in Condition III is included in the drawing.

[2] Th selective presentation of the stimuli was first attempted with the use of polaroid lenses; however, the difficulty of keeping the axes perpendicular, of achieving absolute opaqueness, and of matching brightnesses and contrasts made their use generally unsatisfactory.

Instructions. The *O* was informed that he would see a small black stimulus appear on the left side of his visual field and that it would move to the right a short distance and then disappear. The *E* directed *O* to report the presence of contour only if the edges of the stimulus appeared clearly defined throughout the extent of movement. The criterion was demonstrated to *O* by showing the stimulus moving at a very low velocity (V=4° visual angle/sec). Thereafter, *O* observed several preliminary trials in which both the stationary and moving stimuli were presented. It was emphasized that *O* should fixate the stationary stimulus until movement began and then *track* the moving stimulus until it disappeared; and further, that it was the moving stimulus alone about which contour judgments were to be made.

Procedure. Following the preliminary trials, the moving stimulus was shown to *O* at a low velocity, with $T = 0$. Four successive presentations of the stimulus (a trial) were given, after which *O* reported the presence or absence of contour on the last presentation. By following a modified method of limits, *V* was increased in 1° steps until *O* reported the absence of contour. At this critical velocity, the stationary stimulus was introduced for a brief duration ($T = 10$ msec). The duration of the stationary stimulus was increased in 10 msec steps until *O* reported that contour of the moving stimulus had been regained. Thereafter, *V* was increased until the contour of the moving stimulus could no longer be seen. Again, *T* was increased until contour was restored. The procedure was continued until either the limit of *O*'s discrimination or the limit of the apparatus was reached. This method established combinations of stationary stimulus durations and maximum velocities of movement which would allow the perception of contour during movement.

The relationship of *T* to *V* was determined for each of eight *O*s in each of three conditions: binocular viewing of the stationary and moving stimuli (I); monocular viewing of the stationary and moving stimuli with the preferred eye (II); and monocular viewing, with the stationary stimulus presented to one eye and the moving stimulus presented to the other (III). The order of experimental conditions was random for each *O*. In condition III, five of the eight *O*s saw the moving stimulus with the preferred eye.

RESULTS

Data from this experiment indicate that the introduction of the stationary stimulus prior to the moving one definitely had a facilitating effect upon the perception of the contour of the moving stimulus, regardless of the conditions of viewing.

The data are presented in Figure 2. Here may be seen the relationship between stationary stimulus duration (*T*) and the maximum velocity (*V*) at which contour could be resolved under each of the three viewing conditions. Each function is based upon data obtained from all *O*s, and although there were noted slight variations in slope from individual to

individual, there were no instances in which the pattern of these functions for an individual violated the pattern represented by the combined data.

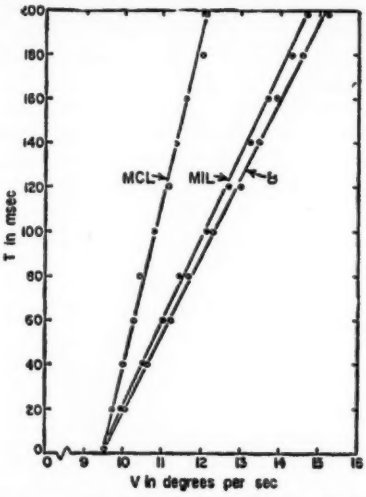

Figure 2. The relationship between the duration of the stationary stimulus (T) and the maximum velocity at which contour could be resolved (V) under each of three conditions of viewing: *B*, binocular (I); *MIL*, monocular ipsilateral (II); *MCL*, monocular contralateral (III).

The reduction from binocular to monocular viewing did not produce any marked loss in the efficiency with which the visual system resolved

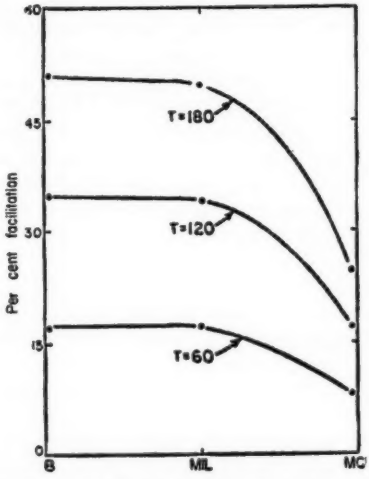

Figure 3. The deleterious effects of restricted conditions of viewing upon contour facilitation for each of three durations of the stationary stimulus (T); *B*, binocular (I); *MIL*, monocular ipsilateral (II); *MIL*, monocular contralateral (III).

contour. However, the slope of the function representing Condition III is higher than the other two, thereby demonstrating that less facilitation occurred under monocular contralateral stimulation than occurred under either monocular ipsilateral (II) or binocular (I) stimulation. Nevertheless, when the stationary stimulus was presented to one eye and the moving stimulus to the other eye, *facilitation did occur.*

In each of the experimental conditions the contour of the moving stimulus could not be perceived at velocities exceeding about 9.5° visual angle per sec *unless* the stationary stimulus was presented prior to movement. When the stationary stimulus duration equalled 160 msec ($T = 160$ msec), V increased from 9.5 to 14° in Condition I, from 9.5 to 13.8° in Condition II, and from 9.5 to 11.6° in Condition III.

The functions shown in Figure 3 indicate the relative effectiveness of the three methods of stimulation upon contour facilitation for each of three values of T. Facilitation is expressed as the per cent increase in the maximum velocity at which contour could be resolved as a result of the introduction of the stationary stimulus prior to movement. Here it may be seen that the longer the duration of the stationary stimulus, the greater is the facilitation of contour within each of the three viewing conditions. However, for any particular value of T, greater facilitation occurred in Conditions I and II than occurred in Condition III.

DISCUSSION

The facilitation of perceived contour during stimulus movement has been shown to be related to visual events preceding movement. The edges of a stimulus which can not be seen clearly at a particular velocity may be seen at that velocity if the stimulus is presented first in a stationary position prior to movement.

In a recent paper (Gulick, 1959) both the role of the stationary stimulus as a locator of the moving stimulus and the influence of the stationary stimulus upon visual memory of the moving stimulus were discussed as possible explanations of the phenomenon of contour facilitation. Although each view was considered to be parsimonious, neither was found to be a satisfactory explanation. A tentative explanation was offered in terms of the contribution of the stationary stimulus to the physiological conditions which were necessary for contour perception.

If we consider contour perception to be dependent upon differential stimulation of the visual system, then there must exist some critical difference between levels of excitation in adjacent areas of the visual system before contour can be perceived. At velocities of movement which exceeded 9.5° visual angle per sec the nature of the stimulation was not sufficient to meet the necessary conditions for contour perception. This insufficiency might be viewed as a failure to obtain a difference in levels of excitation which was large enough to provide O with a clearly defined contour.

The restoration of contour during movement by the prior introduction of the stationary stimulus must have altered the physiological state of the visual system so as to meet the necessary conditions for contour perception. If we assume that a critical, but unknown, difference in

levels of excitation must occur befor contour can be perceived, then it follows that the combined effects of the stationary and the moving stimuli produced this critical difference. Otherwise, contour could not have been perceived. With regard to the data from the present experiment, let us examine further the possible contribution of the stationary stimulus to the fact of contour facilitation.

In the condition in which *O* viewed the stimuli binocularly, portions of the stationary stimulus and the moving stimulus were represented bilaterally. If we assume, for the purpose of discussion, that *O* fixed his sight upon the geometrical center of the stationary stimulus and the moving stimulus, then the left half of each stimulus would be projected upon retinal areas to the right of the midline. Subsequent neural representation would involve the right lateral geniculate body and the right hemisphere of the visual cortex. The opposite relationship would obtain for the right side of the stimuli. That the point of fixation was precisely the geometrical center of the stimuli is unlikely, but the implication that the stimuli were bilaterally represented would be difficult to deny.

In Condition I residual activity following the cessation of the stationary stimulus was present bilaterally at the retinal, geniculate, and cortical levels. Accordingly, new activity produced by the onset of the moving stimulus could have summed with these residuals at any or all of the three levels within the visual system.

In Condition II, wherein *O* viewed the stimulation sequence monocularly with the preferred eye, both the stationary and moving stimuli were represented unilaterally at the retina but bilaterally at the geniculate and cortical levels. Again, the process of summation could occur at any or all of the three levels of the visual system.

In the condition of monocular contralateral stimulation (III), wherein the stationary stimulus was presented to one eye and the moving stimulus to the other eye, no residual activity would be present following the cessation of the stationary stimulus in the eye which was to be stimulated by the moving stimulus. It is clear, therefore, that in this condition the summation process could not have occurred at the retinal level. This suggests that retinal summation is not necessary for the phenomenon of contour facilitation.

Several questions are raised by the fact that the facilitation of contour was less pronounced in the monocular contralateral condition than it was in either of the other two conditions of viewing. From the data it is apparent that facilitation occurred in all three experimental conditions; but equally apparent is the possibility that the removal of the opportunity for summation at the retina, as in Condition III, had a deleterious effect upon the efficiency of the perception of contour in this experiment. Unless factors other than the absence of retinal summation can explain the loss in contour facilitation in Condition III, it may be necessary to consider the process of summation as occurring within the entire visual system—from retina to cortex—rather than in the visual cortex alone, as has been previously suggested.

Beside the matter of the absence of retinal summation as a possible

cause of reduced contour facilitation in Condition III, the problem of eye movements should be considered. It is possible that tracking movements made monocularly were less accurate than those made binocularly. But if this were so, then the effects of reduced accuracy in tracking the moving stimulus should have been apparent in Conditions II and III rather than in Condition III alone. Since contour facilitation in Conditions I and II was practically identical, even though tracking was done binocularly and monocularly, respectively, it may be concluded that the loss in contour facilitation noted in the monocular contralateral condition was not due to the inaccuracy of tracking movements.

On the basis of this experiment we may conclude that contour facilitation occurs in a similar manner and to a similar extent under both monocular and binocular vision provided that the two phases of the stimulation sequence can interact at the retinal, geniculate, and cortical levels of the visual system.

SUMMARY AND CONCLUSIONS

Each of eight *Os* observed a small black square (0.5° visual angle) moving horizontally from left to right through a visual angle of 5.0°. The velocity of movement was increased until *O* could no longer perceive the contour of the stimulus. At this velocity the square was presented briefly in a stationary position prior to movement, and this served to restore contour during movement. The relationship between the duration of the exposure of the stationary stimulus and the maximum velocity at which contour could be resolved was found to be linear. This relationship was determined for each of three conditions: binocular viewing of the stationary and moving stimuli (I); monocular viewing of the stationary and moving stimuli with the preferred eye (II); and monocular viewing, with the stationary stimulus presented to one eye and the moving stimulus presented to the other eye (III).

Facilitation of contour perception of the moving stimulus occurred in all three conditions, although facilitation was less pronounced in Condition III. In certain instances, the maximum velocity of stimulus movement at which contour could be resolved was increased up to 50% by the introduction of the stationary stimulus.

The facilitation of contour perception during stimulus movement occurred to the same extent under conditions of either monocular or binocular vision provided that the residual neural activity following the cessation of the stationary stimulus could sum with the activity produced by the moving stimulus at the retinal, geniculate, and cortical levels.

The stimulation of one eye was shown to effect subsequent contour perception involving the contralateral eye.

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PERSPECTIVES IN PSYCHOLOGY

XIV. PSYCHOLOGY IN THE LIBERAL ARTS CURRICULUM[1]

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The following is a part of the annual report of the Chairman of the Department of Psychology to the President of Colton College, dated June 1, 1965.

In the fall of 1960, at your request, the Department of Psychology launched a study of the place of psychology in the liberal arts curriculum of Colton College. Two years were spent in a detailed examination of our curriculum and methods of instruction. In the fall of 1962, having arrived at certain conclusions regarding the role of psychology in the liberal arts, we began our new program. We have now had three years experience in the teaching of the new curriculum and this report embodies our observations to date.

It was apparent to us from the outset that the liberal arts as defined at Colton College involve four aims. These four aims, as described in the words of the Harvard report on general education, are to help the student to think effectively, to communicate thought, to make relevant judgments, and to discriminate among values (Buck et al, 1945). It was equally apparent to us that we should not be concerned with vocational preparation. With these two points in mind we have decided to ignore specific techniques and factual details which have vocational rather than liberalizing implications. Rather than concentrating on the facts as significant in their own right, we have sought to develop a basic understanding of psychology as a scientific discipline and as a basis for understanding one's self and other people.

We realize that in adopting these aims we may be accused of reverting to the outmoded concept of formal discipline. It is our opinion however that while the doctrine of formal discipline based upon a faculty psychology was quite properly buried years ago, psychologists have frequently gone too far in asserting that knowledge and skills are always specific to unique situations. Higher education should aim at breadth of understanding while at the same time not ignoring significant details. We feel that instruction in psychology at the undergraduate level should have liberal objectives and that to promote such objectives we should teach for as much transfer as may conceivably

[1] This article is based upon a paper presented at the meeting of the Ohio Psychological Association held at Dayton, Ohio on October 17, 1959.

be possible. In pursuing this aim we feel that we are not necessarily embracing the doctrine of formal discipline or accepting exaggerated claims regarding transfer of training. Generalization and transfer do occur and instruction should be aimed at maximizing them.

In our study we quickly became aware of the fact that psychology is envied in some quarters, accepted rather grudgingly in others, and severely criticized in still others. Much recent criticism of psychology has come from the humanistic disciplines which have traditionally been regarded as the guardians of the liberal arts. Few humanistic scholars today would go as far as Spengler who referred to scientific psychology as "The shallowest and most worthless of all the disciplines of philosophy, a field so empty that is has been left entirely to mediocre minds and barren systematists" (1939, p. 299). Nevertheless we find even today such writers as Joseph Wood Krutch (1953) who feels that scientific psychology, proceeding on the basis of mechanistic assumptions, threatens to deprive man of that freedom which, however slight, has always been man's glory. After careful study of these and similar criticisms we have concluded that the study of psychology at the undergraduate level should involve a consideration of the assumptions on which scientific psychology rests and the implications which such a psychology has for the individual and for society. Questions regarding the nature of man are nowhere more relevant than in the psychology classroom. If metaphysical considerations need be involved in order to do full justice to the complexity of the human situation, then they should be squarely faced, not avoided. Since psychology has been emancipated from philosophy it has tended to be disdainful of philosophical claims. The bonds which were too completely severed should be re-established for the benefit of both psychology and philosophy.

C. P. Snow (1959) has written of the gulf of mutual incomprehension, and sometimes of hostility, which separates the culture of literary intellectuals from the culture of scientists. After some soul-searching we concluded that psychology has unfortunately contributed to this mutual incomprehension. Like the humanities, psychology is concerned with man. What could provide a better basis for common undertakings and common understandings? But the fact of the matter is that the chasm separating psychology from the humanities has grown broad indeed. Psychoanalysis has provided a bond, it is true, but psychoanalysis is widely disavowed by academic psychologists, and has a very small place in the psychology program of Colton College. Of late, phenomenologists and self-psychologists have attempted to bridge the gap and have made contact with scholars in the fields of literature, philosophy, and religion. Scientific psychology on the other hand has become more specialized, more objective, and the style of psychological writing has grown increasingly more crabbed and lacking in appeal for the general reader. If in our teaching we can occasionally speak the language of art, literature, philosophy, or religion we shall not only

help our students to bridge the chasm but may also decrease our feelings of isolation. Plain talk, without condescension, with our colleagues in other departments should also be helpful.

Even more serious than the neglect of general philosophical issues relating to the nature of man has been the failure of psychologists to give proper attention to problems of value. Values are after all preeminently psychological in nature and the empirical study of values as a branch of psychology is greatly to be desired. Psychology as a scientific discipline can and should deal with instrumental values. While psychologists may not pretend to solve problems of ultimate value they can contribute to an understanding of seemingly irreducible value factors embedded in man's bio-psychological makeup.

Value problems everywhere confront the psychologist and he can avoid them only through the plea that psychology as an objective science must be kept ethically neutral. As soon as one attempts, however, to establish norms of adjustment, goals for psychotherapy, ideals for education, and the like, he becomes inextricably entangled in value questions. We have taken the position at Colton that as scientists we should try to maintain an objective approach to problems of behavior. At the same time value questions are pressing for solution and, since we are citizens as well as psychologists, we cannot ignore them. As teachers of undergraduates we feel that it is our duty to pose value questions as they involve psychology in as fair and open a manner as possible. Howard Mumford Jones (1958) has asked how the outcome of psychological conditioning can be anything but a robotized society. He and our students who ask similar questions deserve replies. Clearly Professor Jones implies that a robotized society would be bad. But what is meant by a robotized society or even by a robotized man? Facts and values must be disentangled if the question is to be given a meaningful answer. To cite another brief example, Albert Ellis is quoted as having said, "No human being should ever be blamed for anything he does" (*Time*, Sept. 14, 1959, p. 69). We might ask in what sense, if any, Dr. Ellis is speaking here as a scientist. Is this the kind of statement which can be put in the "if---then" form and subjected to possible verification, or is it merely a statement reflecting an emotional reaction on the part of the speaker? Or is the proposition a purely normative one in the traditional sense? Or is it one which intermingles factual, emotional, and normative components? Of course any answer at all would presuppose that we have arrived at an acceptable definition of the word "blame." It would seem quite illiberal for a teacher of psychology to present such a statement as the above as an *obiter dictum*. On the other hand, it seems quite proper and indeed essential for the teacher to present this sort of statement in its full context as a problem calling for a decision on the part of the student. When students and their instructors tackle such problems an opportunity is provided for developing analytical skills. At the same time the student comes to feel that

psychological insight can be effectively employed in the solution of significant personal and social problems.

Most annoying to us was the criticism by Jacques Barzun (1959) that psychology enjoys great popularity among students primarily because its courses are extremely easy. We are convinced that this is not the case at Colton even though the enrollment in psychology is exceeded only by that in the Department of English. After giving more thought to the criticism we did decide to abandon some of the less rigorous courses, incorporating their content in other courses when it was felt to be important. We have therefore dropped the Psychology of Adjustment and its content is presented in a unit of the introductory course. Courses which were offered in applied psychology, industrial psychology, and personnel psychology have been combined into a three-hour, one-semester course. This course, which is both respectable and popular, has been programmed for machine teaching. When students have thoroughly mastered the basic content we turn to the case method of instruction which is then used for the remainder of the semester.

Another criticism of the teaching of psychology is that much of the content is presented simply as discrete factual information and is frequently irrelevant to the student's fund of significant information. Critics who raise this point are objecting not merely that the facts and principles learned do not seem to have an immediate application, but that the facts mastered solely by rote learning are not interrelated in significant ways. A student, for example, might be able to describe a temporal maze without having any understanding of its value as a research tool or of the implications of temporal maze studies for theories of the symbolic process.

Still another criticism often raised by students of the humanities is that psychology tends to ignore complex events which defy rigorous analysis by existing methods. Yet such events are often the most significantly human with which we have to deal. We have agreed that within our new program we shall find a place for the study of those complex aspects of human behavior which are of most interest and concern to students even though techniques are not yet available for reducing them to the language of conditioning, factorial analysis, or physiological drive. At this point we feel that we can best cooperate with scholars in the humanities in gaining insight into human behaviors which existing experimental techniques have as yet failed to penetrate. To the point here is the remark by Aristotle that "it is the mark of an educated man to look for precision in each class of things just so far as the nature of the subject admits" (Aristotle's Ethics 1094[b]).

It is probably increasingly true that psychologists tend to be contemptuous of earlier attempts to understand human behavior. What we might call the error of contemporaneity is the tendency to think that no significant progress had been made in understanding human be-

havior prior to 1879, 1912, or perhaps for some younger psychologists, 1943 or 1950. In our program we have attempted to combat this tendency by requiring a one-semester course in the history of psychology of all majors. Hull (1959) has recently advocated the study of the history of a discipline as a significant approach to the correlation and integration of knowledge. He writes:

> "Students of different subjects are like men exploring the branches of neighbouring trees. A man cannot understand other people's problems by interrupting his own work to climb a few feet up their trees. His time will be better spent on his own tree. As he climbs higher, he will find its branches interlaced with those of the others. As he works downwards, tracing its roots, he will find them entangled with other roots, nourished in the same soil. The individual trees are now so extensive that few men have time or ability to reach many of the upper branches. It is comparatively easy to learn something of the roots. Here, surely, in the historical approach, lies the practical solution of the problem. Let everyone know the history of his own subject. He will find its origins in the same human problems and purposes as have given rise to other subjects. He will see that other men, with similar motives, are often seeking the same ends by other means. He will regard their efforts with sympathy. He will know that, by persevering in his own way, he may in time meet them again high above the ground." (p. 325)

We have further attempted to introduce historical perspective in our other courses as time permits and we are not averse to asking students to read James, Hall, or even Hume or Locke whenever we feel it appropriate.

At Colton, psychology is classified as a natural science. This is where we want to be and where we feel we ought to be. At the same time we feel strong affinities with the social sciences and with the humanities which are also concerned with vital human problems. We tend to see the Department of Psychology as a bridge which can help to unite the three broad areas of the liberal arts curriculum. Unification, not isolation, is our objective.

It was the opinion of the majority of the staff that the most fruitful approach to psychology is one which combines a strong faith in experimentation and objectivity with an interest in the full range of human behavior as exhibited, for example, in political, economic, artistic, educational, and scientific activities. The systematic position of the Colton staff can be characterized as behavioral or behavioristic in the broad

sense. A few staff members have a decided preference for a more phenomenological approach but they have consented to go along with the majority in planning the new curriculum.

Feeling that many students would not and perhaps could not take more than one course in psychology, we decided to embody as many liberal arts values as possible in the introductory course. This course has been established as a two-semester, six-hour lecture and discussion course. The staff felt very strongly that while many eclectic textbooks present samplings of psychological data and principles in an admirable manner, they lack the unity which is necessary for giving the student a clear perspective of the field. This consideration we felt to be particularly important for the student who will not have further formal opportunities for increasing his understanding of psychology. We therefore decided to examine several texts which have been written from consistent points of view. Among these were Hebb's *A Textbook of Psychology*, *Individual Behavior* by Combs and Snygg, and the one which we finally adopted, Skinner's *Science and Human Behavior*.

We found it necessary to supplement the Skinner book with textual material covering physiological factors in behavior, heredity and environment, perception, and psychological testing. All of the content of the introductory course has been programmed for machine teaching using up-to-date machines derived from the prototypes developed by Sidney Pressey and B. F. Skinner. By use of the machines we have been able to cover all of the factual material quite thoroughly in one semester. In the second semester considerable time is devoted to experiments and demonstrations designed to give students a firsthand acquaintance with scientific procedures as they are employed in psychology. The remaining time is devoted to the discussion of problems which can be approached, if not always solved, within the framework of the concepts already mastered. These problems range from the improvement of classroom learning to such far reaching problems as labor-management conflict, delinquency, and the control of morality. Students are encouraged to abandon insofar as possible the common vernacular and strictly a commonsense approach. They are given experience in the use of a system language and are made aware of the need for rigor in approaching human problems scientifically.

We have not found that machine teaching is in the least incompatible with liberal arts objectives. As a matter of fact, the rote learning aspects of psychology which we consider indispensable have been separated from, although they are of considerable use in, the classroom experience. No longer is the teacher simply a lecturer or drillmaster. Students, better grounded in the fundamentals, expect more from their instructors and instructors in turn find that they are put on their mettle and stimulated to make their teaching more challenging and thought-provoking. Freed from working with the trite and the humdrum they

can lead their students into those paths where no one's step is certain but where discovery leads to immense satisfaction.

Insofar as possible we have attempted to establish continuity between introductory, intermediate, and advanced courses. We have taken seriously Wolfle's (1947) admonition to avoid overlap in the curriculum. While many of the topics covered in the introductory course are treated elsewhere, there is considerable difference in the level of treatment. In the advanced courses more time is devoted to a careful analysis of the literature of the field and to diverse theoretical approaches.

In planning a curriculum with sound liberal arts objectives we found the study, *Improving Undergraduate Instruction in Psychology* (Wolfle, Buxton, Cofer, Gustad, MacLeod, and McKeachie, 1952) and the book, *College Teaching*, by Buxton (1956) most valuable. We have adopted their goals of teaching psychological facts and principles, encouraging scientific thinking, illustrating scientific method, and developing in the student habits of careful observation, quantitative thinking, and awareness of the complexity of human events. We have also attempted to inculcate ideals of scholarship by constantly requiring students to stretch their intellectual powers. Recognition of the limitations of present knowledge and of the need of caution in application are also emphasized.

Our service courses, while somewhat less demanding than major courses, follow much the same pattern. These include Educational Psychology, Child and Adolescent Development, and Industrial and Personnel Psychology. Other psychology courses frequently elected by non-majors are Social Psychology, Personality: Normal and Abnormal, Biographical Psychology, Psychology and Literature, and the Psychology of Religion.

Psychology majors are required to take the following courses:

Freshman or Sophomore Year: Introductory Psychology—6 hours

Sophomore Year: Psychological Statistics—3 hours

Junior Year: Experimental Psychology—6 hours
Personality: Normal and Abnormal—6 hours
Tests and Measurements—3 hours
Social Psychology—3 hours

Senior Year: History of Psychology—3 hours
Systematic Psychology—3 hours
Senior Project—3 hours
Seminar—3 hours

Majors are also required to take the following courses in related fields: Mathematics through Calculus; General Biology, General Physics or General Chemistry; The History of Science or The Philosophy of Science; an advanced literature course; and a foreign language. Courses

strongly recommended include Human Physiology, Genetics, Evolution, Anthropology, and Ethics.

It will be noted that senior majors must complete a project which is usually experimental in nature. The student is expected to survey the literature, design his own experiment, and carry it out to the best of his ability. An adviser meets with him regularly and is always available for consultation. In unusual cases permission may be given to conduct a survey or to write a theoretical or historical paper.

Outstanding students are encouraged to work for honors. Honors candidates are expected to complete a two-semester project carrying six hours of credit. The final paper must be approved by a three-man faculty committee and at least one committee member must be appointed from an outside department. Frequently the honors project leads to publication or to a continuation of the research in graduate school. In exceptional cases our graduates have had as many as four or five papers to their credit by the end of the first year in graduate school.

The seminars are given on a variety of subjects in accordance with the interests of faculty members and students. A few which have been given recently or are planned for the near future are Psychology and Human Values, Phenomenological and Existential Psychologies, Modern Learning Theory and Classroom Teaching, The Use of Mathematical Models in Psychology, and Problems of Man in an Age of Automation. Students are expected to assume considerable initiative in the seminar since the success of the course depends primarily upon the extent of their participation. The instructor is responsible for preparing a reading list and, while some specific assignments are made, students are expected to read widely as their interests dictate. The outside reading frequently includes material from the physical and biological sciences, sociology, economics, and philosophy, and provides encouragement for integrating materials from diverse fields. Both the seminar and the project are designed to challenge the superior student and to motivate the intelligent student who has failed to find himself in less stimulating courses.

Our program is probably not significantly different in outline from that offered at many colleges. Yet we feel that we have been more than moderately successful. Much more responsibility is placed upon the student than is usually the case in an undergraduate college. In most of our courses machine teaching has simplified the problem of mastering content. The form and content of lectures have been modified considerably. Instructors now use the lecture primarily to present original analyses and syntheses. The students, having been well drilled in fundamentals, follow the lectures more readily and participate more fully in class discussions. Wide-ranging outside readings help to raise the level of performance and encourage breadth of understanding.

While textbooks are still being used to some extent they are playing a much less significant role in our program.

Perhaps the best evidence regarding the success of the first three years of the new program comes from the students themselves. Psychology courses are considered very popular and worthwhile but demanding. Students report that they enjoy the experience of being challenged intellectually and that they find themselves growing in insight into the nature of man. The introductory course is taken by nearly all students at Colton and all but a few report that the course has exceeded their expectations.

Of the twenty-four majors graduating last year, fourteen are continuing in graduate or professional schools. Ten of the fourteen intend to teach psychology at the undergraduate level. With further training some of the group will undoubtedly make important research contributions and perhaps most of them will make minor contributions of a research nature. These facts plus the enjoyment we have derived from teaching our revised program have made us feel that we are making progress in keeping with the highest liberal arts traditions. In our opinion our graduates are well grounded in the sciences and in psychology as a scientific discipline. At the same time their introduction to the problems of the field has been broad, not narrow, overspecialized, or doctrinaire. We hope that as a group they will reflect credit upon Colton College and upon psychology as a science and as a liberal discipline. Our efforts have been reinforced sufficiently to insure our continuing them for some time without much likelihood of extinction.

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MONOCULAR REGARD AND DECREMENT TO THE MULLER-LYER ILLUSION[1]

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The conclusion of Köhler and Fishback (1950 a & b) that decrement to the Müller-Lyer illusion was a type of figural after-effect was not supported by the findings of Mountjoy (1958 a & b). These studies were conducted under binocular conditions. Since Hammer (1949) had obtained significant after-effects with test and inspection figures of the type generally used in studying figural after-effects, but with monocular vision, it was decided to compare the course of decrement to the Müller-Lyer figure under both monocular and binocular conditions.

METHOD

Subjects. Thirty-six students enrolled in introductory psychology courses at Denison University were assigned randomly to either of two experimental conditions (monocular & binocular).

Apparatus. The figure was presented in a slightly modified model of an apparatus which has been described elsewhere (Mountjoy, 1958 a & b). The major modification was that the comparison arrowhead could be set at any place between 73 mm of illusion and 87 mm of negative illusion. In the earlier model the comparison arrowhead could be set at any position between 125 mm of illusion and 29 mm of negative illusion.

Procedure. A measurement of initial illusion magnitude was obtained for each S, in the guise of a "practice trial," under conditions of binocular vision and a 5-sec. adjustment period. The S was instructed to set the points of the arrowheads equal and to tap a telegraph key once each second when the shutter was closed. Monocularity was achieved by covering the non-dominant eye with a patch. An additional 30 trials were given to all Ss under conditions of a 20-sec. exposure period, a 5-sec. adjustment period, and a 5-sec. intertrial interval. The next day each S received a "practice trial" (5-sec. adjustment period) under the appropriate monocular or binocular conditions. An additional six trials were administered with a 20-sec. exposure period as on the previous day.

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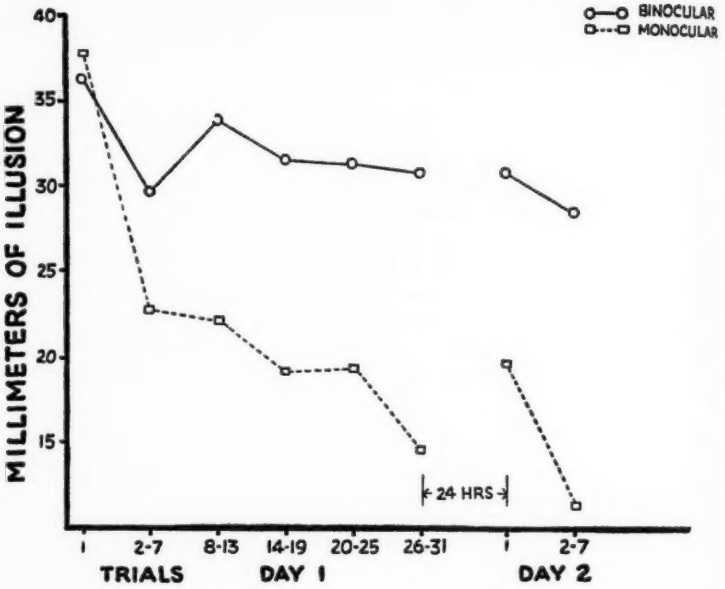

Fig. 1. Millimeters of illusion as a function of trials, days, and monocular vision.

RESULTS AND DISCUSSION

A *t* test between the initial trial of day one for the two groups was not significant, indicating no systematic differences. Trial one of day two was included in the analysis of variance for repeated measures carried out on the blocks of trials.

The *F* value between groups (7.04; *df*: 1,34) fell between the .05 and .01 levels of confidence, indicating that monocular vision did affect performance. The *F* for blocks (4.88; *df*: 6,204) was significant far beyond the .01 level. The interaction between blocks and groups was less than one. It is shown in Fig. 1 that greater decrement occurred with the monocular condition. To determine whether significant decrement occurred on day one, *ts* for paired measures were calculated between blocks two and five. The *t* for the binocular group (1.27; *df*: 17) was not significant, while that for the monocular group (2.77; *df*: 17) attained the .01 level. A corresponding *t* between trial one and block

one indicated the binocular group did not change significantly (1.77; *df*: 17), but the monocular Ss' decrement was significant beyond the .01 level (3:00; *df*: 17). Decrement on day two was not significent for either group, nor was a similar analysis for spontaneous recovery between the last block of day one and trial one of day two.

Some factor other than monocularity might have been associated with wearing the eye patch. For example, a motivational variable may have been introduced by Ss interpretation of the eye patch as a visual handicap. Research is being conducted upon motivational variables.

SUMMARY AND CONCLUSIONS

Decrement to the Müller-Lyer illusion was investigated under monocular and binocular visual conditions. The monocular group exhibited statistically greater decrement than the binocular Ss. The causal relation of monocular vision to this marked decrement is unknown.

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Neither of these books should be read by psychologists who have in mind a specific *N* for experimental subjects; nor should they be read by those who firmly believe that their particular system of logic or psychology transcends reality and must be applied to all inquiries, else they become spurious.

Others, particularly those interested in exploring new approaches to behavioral science, or in reading a careful, methodical exposition of an already established system of recording human behavior, will be delighted by both books.

Garner and Wenar have approached a relatively small number of cases but with well determined referents in mind. They also give far more than lip service to the need for study of the *inter*-action, in this case interaction between certain sorts of mothers and certain sorts of children. They are most explicit about their postulates, and seem to move gracefully through the book, to alter and change these as deemed necessary by the conditions of their methodology and as their findings unfold. At times I felt a little confused by the welter of detail, and at times felt no particular purpose was being served by this much discussion of the in's and out's of a complex research project; yet the overall effect was a good one, the details succinct and no one can complain that the conceptions, the methodology, the experimental findings, or the conclusions were not spelled out. This book is a prime example of a new and healthy trend in research programs, both as to the method of approach to the problem (open-ended and open-minded) and as to subject matter (belatedly, the area of interaction between two individuals). The fact that they also studied psychosomatic disorders, with results exciting in themselves and of significant value in this new research area, seems secondary.

The second book, by French, violates classical experimental techniques in two ways: it uses only one case, and at that a case seen many years ago by another person; and it ostensibly is based on pre-formed psychoanalytic systems. The case is that of a laborer who sought and got relief from his asthma, in a psychoanalysis by Dr. Helen McLean, some twenty-five years ago, maybe more. This case, however, has simply been the focus of French's study of the larger problem of ego function as that term is generally understood; he actually prefers 'integrative functioning'. Also this volume, number three of a proposed five, is but one logical

step in the entire exposition. French brings to it not just one case, if anyone is so naive as to really believe so, but a lifetime of careful study of ego-integrative processes, plus working and re-working of the original data of a typical case; this work has been done not by French alone but also by what has now become a generation of students at the Chicago Institute for Psychoanalysis, where he has taught the material in this book.

I know of no other printed source where the reader can find such intimate facts about the cloistered raw material of psychoanalysis. On that basis alone, the book merits the serious attention of scientific readers. However I think that his main contribution is his theoretical activity. This was the basis, perhaps, of the second objection mentioned above. I do not believe the objection to be correct, nor do I think that any psychologist or psychiatrist who gives French two things would think so either. The two things are (1) more than a cursory glance, i.e., taking the time to read through and absorb the complete book; and (2) not commit the same error he would accuse French of, namely approaching the material with preconceived formulations. French has spent time, his and his students' time, to thoroughly acquaint himself with the incredibly complex aspects of the interaction between an analyst and a patient (thus eliminating one variable, himself as the analyst). He has also, I believe, never been bounded by the original psychoanalytic structuralizations of Freud. French has not attempted to encompass all of psychology, nor to give a powerful 'total answer' to anything. He has busied himself with the time sequence of a psychoanalysis and with especial attention to the ego as it looks to us, and as it appears to be structured at given moments, how it alters as a result of interpretations by the other person in the room (the analyst) and how one can develop a moving picture, as it were, of the ego, rather than a cross-sectional snap shot.

As in the Garner and Wenar book, the psychosomatic aspects are interesting in their interplay, and seemingly tangled existence with the emotional factors. I think the aspects mentioned already are of more significance to the readers of this journal. I would not suggest reading volume three alone. If the psychologist is willing to spend his time and give a bit of feeling to the inquiry, then a summer spent absorbing French's three volumes would give a sound picture of psychoanalytic thinking today, as it attempts to further define areas of psychic functioning only crudely etched by Freud; it might also prove, as it has for me, an exceptionally fertile source of new ideas, new nuances of understanding into human behavior, even new directions for research. It is not based, in any sense, on the existing schemes for rigidly controlled experimental psychology and I would advise such readers not to bother, unless they wish to explore new realms and try new tools.

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The Psychological Record, 1960, 10, 147-149.

Bindra, Dalbir *Motivation: A systematic reinterpretation.* New York: The Ronald Press, 1959. Pp vii+361.

In experimental psychology, there has not been a text in the area of motivation between Young's *The Motivation of Behavior* and the subject of this review. McClelland's *Studies in Motivation* cannot present the intergrated approach of a freshly written volume by a single author. For student and scholar there have been in addition only the Nebraska Symposia, consisting of rather specialized papers, and various summaries, such as the chapters on motivation in Stevens' *Handbook of Experimental Psychology.* Bindra's book therefore fills a need. Since the area of motivation is ill-defined, disorganized, and sometimes hard to differentiate from other areas in psychology, we should be especially grateful for a volume in which a serious and fresh attempt is made to bring order out of chaos.

Bindra has succeeded in the difficult task he set for himself regarding the manner of presentation: "I have aimed at writing . . . in such a way that the undergraduate, given occasional guidance, will not find it too difficult and the graduate student and research worker will not find it too elementary." Certainly it is not "written down" for the competent psychology major. I found it interesting, stimulating, and well enough documented to provide a good starting point for detailed study of a given topic. The author follows a strictly experimental approach, having no place for generalities on personal adjustment, personality theory, and the like. Professor Bindra writes in the best academic tradition: he does not compromise with rigor, and yet he does not revel in obscurity.

The book is subtitled "a systematic reinterpretation." Bindra does not present a formal system, but he suggests "generalizations" at various points. While he feels that these represent genuine psychological laws, he hesitates to call them such until more evidence has accumulated. He rejects the traditional "explanation" of goal-directed behavior by subsuming it under drive, need, or other such construct. His reinterpretation is indicated by the way in which he presents the questions that the book is supposed to cover:

> The first general question is concerned with the *origin* of directed activities. How are responses patterned into complex, "purposive" activities? What factors determine their development in the animal's repertoire? The second question concerns the *occurrence* of directed activities. How is it that certain types of directed activities occur at a particular time and others do not? What specific factors affect the

> frequency, rate, and timing or periodicity of the various classes of directed activities? These two questions incorporate all the problems that are usually discussed under the heading of motivation. (p. 18)

The author devotes roughly the first half of the book to the first group of questions. The four chapters are entitled "Motivational Phenomena," "Goal Direction," "The Development of Motivational Activities," and "An Analysis of Reinforcers." The activities covered are often called "drive behaviors," that are common to many species and important to biological well-being, e.g., eating, drinking, reproductive behavior, exploration, and so forth. Bindra quarrels with past reifications seeking to explain such behavior by the action of "instincts." Instead, he emphasizes the role of learning, particularly the occurrence of positive reinforcers. The contribution of experience to these presumably basic activities is systematically treated and carefully documented.

The second group of questions is treated in the second half of the book in four chapters entitled "Factors Determining Habit Strength," "The Role of Sensory Cues," "Arousal and Behavior," and "The Role of Blood Chemistry." Bindra's discussion of these topics suffers from a failure to make two important distinctions. The first is the traditional distinction between learning and performance, and the proper grouping of variables in each area. He introduces into the area of motivation concepts that traditionally belong in learning, such as habit strength and the role of the number of reinforcements in its development. Now Bindra may not believe that the traditional distinction between learning and motivation is justified, and he may be right, but the shortcoming of his book is that he never presents it at all, or his reasons for rejecting it. This is a disservice to the student who does not know the areas. In *Dynamics of Behavior*, Woodworth recently stated the whole problem of the relation between learning and production of behavior much more clearly and cogently than does Bindra in his entire book.

A second distinction that Bindra fails to make clear is that the occurrence of his "directed activities" (the "drive behaviors" described above) may be subsumed under the more general problem of the occurence of *any* activity. It is never clear whether he is writing about the conditions of occurrence of the motivational phenomena treated in the first half of the book, or of behavior in general. Certainly the literature cited in the second half, being largely from the area of learning, deals with behavior broader than the eating, nesting, etc. covered in the first half. But Bindra tries to give unity to his book by writing as if the last half merely treated the occurrence of such phenomena. As a kind of afterthought he brings the occurrence of other behaviors into the concluding chapter:

> In this book the two general questions, one concerned with the development of activities and the other with their occurrence, have been discussed only with reference to the so-called motivational phenomena. This category . . . includes those activities with reference to which the traditional "dynamic" concepts . . . have been defined. However, a moment's reflection will show that the same two questions can also be legitimately asked in connection with perceptual responses and other cognitive activities, such as motor skills, problem solving, and verbal behavior. Thus by asking about motivational phenomena the same questions as can be asked about "nonmotivational" phenomena, the present approach brings together different behavioral phenomena into a single general scheme. (p. 291)

It will be helpful if Bindra can, in a later edition, make this distinction much earlier in the book, and can specify the "moment's reflection" in a few pages of prose.

A major shortcoming of Bindra's *Motivation* is the omission of human activity from the scope of the volume. Studies with this species are presented at length only in one chapter, that on arousal and behavior, the reason being that human beings are normally used in the experiments concerned. If, for example, monkeys were the standard subjects for such studies, the human species would have been denied its role even in that part of the book. It would seem essential to recognize that the motivational activities of human beings *are* broader than those of animals, and that there *are* social drives and cultural activities peculiar to human beings. At the end of the book Bindra criticizes the traditional approaches to the analysis of human drives, needs, and motives, and he sketches a plan by which the approach presented in his book could be applied to human behavior. The realization of such a plan would be a good test of the generality of Bindra's approach, and he should be encouraged to undertake a companion volume realizing his own suggestions.

This book would be an excellent text. The author presents some excellent discussions, and suggests some provocative experiments; the teacher should find it to be a stimulating source of ideas. On the other hand, he will find places where the cogency of an argument may be questioned, or where it will be necessary to supplement the literature cited. On the whole, I feel that psychologists owe Bindra a vote of thanks for a competent, well written, and stimulating book on motivation. We may hope that he will in due time prepare a second edition that will overcome the shortcomings remaining in the first.

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